02 Human Health and Disease

1. Introduction :

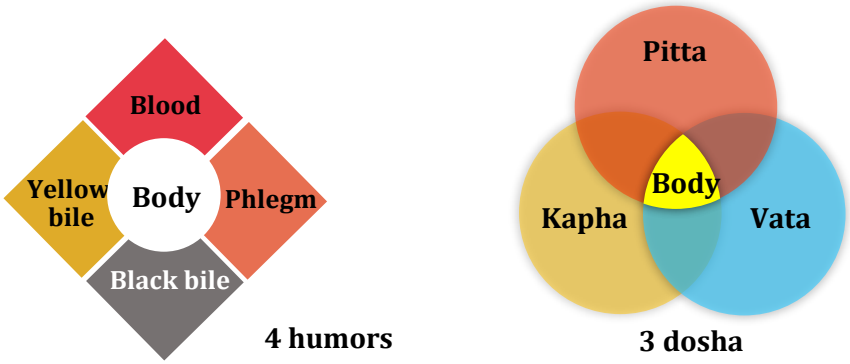
Health :

(i) Old view about health (i.e. Good humor hypothesis of health):

- Asserted by : Early Greeks like Hippocrates as well as Indian Ayurveda system of medicine.
- Health : State of body and mind, where there was balance of certain 'humors'.

Early Greeks like Hippocrates

- Persons with 'black bile' belonged to hot personality and would have fevers. This idea was arrived at by pure reflective thought.



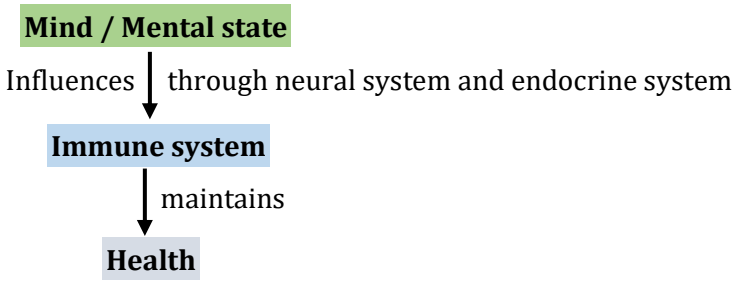
4 humors 3 dosha

Indian Ayurveda system of medicine

- **Disproved by :** The discovery of blood circulation by William Harvey using experimental method and the demonstration of normal body temperature in persons with black bile using thermometer.

(ii) Modern view about health:

- Health ≠ absence of disease or physical fitness
- Health: State of complete physical, mental and social well-being



(iii) Health is affected by:

(i) Genetic disorders : Deficiencies with which a child is born and deficiencies / defects which the child inherits from parents from birth

(ii) Infections

(iii) Life style :

- Food and water we take
- Rest and exercise we give to our bodies
- Habits that we have or lack
- e.g. Drug and alcohol abuse also affect our health adversely.

(iv) Benefits of being healthy:

- Efficiency at work ↑ → Productivity ↑ → Economic prosperity
- Longevity ↑
- Infant and maternal mortality ↓

(v) Very important to maintain good health:

- Balanced diet
- Personal hygiene
- Regular exercise

Yoga : Yoga has been practised since time immemorial to achieve physical and mental health.

(vi) Necessary for achieving good health:

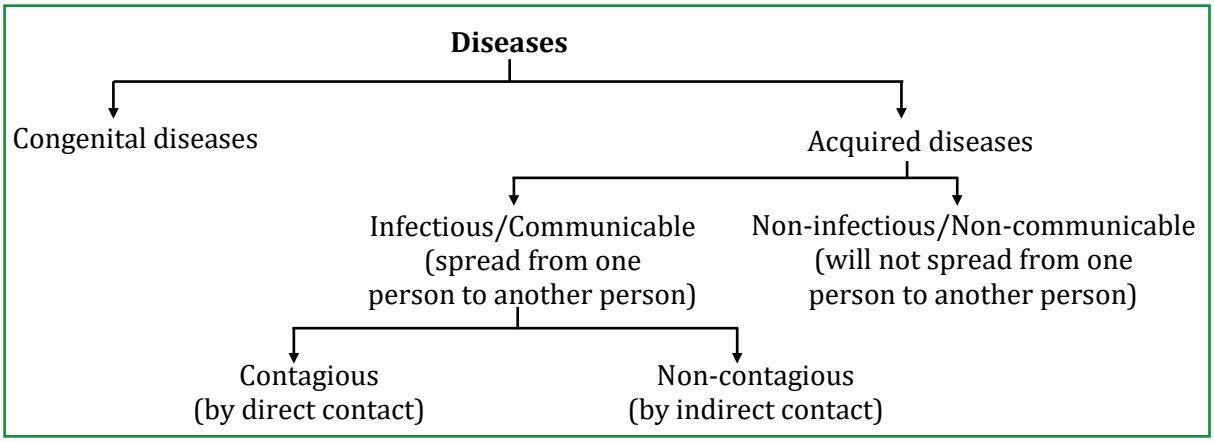
- Awareness about diseases and their effect on different bodily functions.
- Vaccination (immunisation) against infectious diseases.
- Proper disposal of wastes.
- Control of vectors.
- Maintenance of hygienic food and water resources.

Disease:

- Functioning of one or more organs or systems of the body is adversely affected.
- Characterised by various signs and symptoms.

2. Classification of diseases :

- Diseases can be broadly grouped into infectious and non-infectious :


Diseases
Congenital diseases
Acquired diseases
Infectious/Communicable (spread from one person to another person)
Non-infectious/Non-communicable (will not spread from one person to another person)
Contagious (by direct contact)
Non-contagious (by indirect contact)

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3. Common Diseases in Humans :

Introduction to common diseases in humans

Pathogens :

- Pathogens are disease causing organisms (belonging to bacteria, viruses, fungi, protozoans, helminths, etc.).
- Most parasites are therefore pathogens as they cause harm to the host by living in (or on) them.
- Pathogens have to adapt to life within the environment of the host.
  e.g. The pathogens that enter the gut must know a way of surviving in the stomach at low pH and resisting the various digestive enzymes.

How do pathogens create their pathogenicity inside our body?

Entry of pathogen into our body by various means
↓
Multiplication of pathogen and interference with normal vital activity of our body
↓
Morphological and functional damage to our body

Examples of infectious diseases in humans :

Type of disease	Examples
Bacterial	Typhoid, Pneumonia, Dysentery, Plague, Diphtheria, Tuberculosis, Whooping cough (Pertussis), Cholera, Leprosy, etc.
Viral	Common cold, Dengue, Chikungunya, Polio or Poliomyelitis, Influenza, Measles, Chicken pox, Mumps, Rabies, SARS (Severe Acute Respiratory Syndrome), Swine flu, Covid 19, etc.
Protozoan	Malaria, Amoebiasis (Amoebic dysentery), etc.
Helminthic	Ascariasis, Elephantiasis (Filariasis), etc.
Fungal	Ringworms, etc.

S.No.	Bacterial Diseases	Pathogen	Symptoms & Pathogenicity
(1)	Typhoid fever	***Salmonella typhi***	• Enters small intestine through contaminated food and water and migrate to other organs through blood • Sustained high fever (39-40°C) • Weakness, constipation, stomach pain • Headache, loss of appetite • In severe cases intestinal perforation, death • **Widal test** • **Mary Mallon**, Nicknamed- Typhoid Mary (Carrier of typhoid)

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(2)	Pneumonia	***Streptococcus pneumoniae*** ***Haemophilus influenzae***	• By droplet or aerosol infection or use of glass or utensils of infected person • Infects alveoli of the lungs • Alveoli get filled with fluid leading to severe problem in respiration • Fever with chills, cough & headache • In severe cases lips and nails turns gray to bluish in colour
(3)	Dysentery (Shigellosis)	***Shigella dysenteriae***	• Abdominal pain • Blood & mucus in the stool • Transmits through faecal oral route
(4)	Plague (Black death)	***Yersinia pestis*** Parasite of ***Xenopsylla cheopis*** (Rat flea)	• High fever, headache • Enlargement of axillary lymph nodes • Pneumonic (lungs)..... septa between alveoli rupture • Septicemic (blood poisoning)... Black Death
(5)	Diphtheria	**Corynebacterium diphtheriae**	• High grade fever, affects throat • Causes suffocation **(Investigation : Schick test)**
(6)	Tetanus (Lock jaw)	***Clostridium tetani***	• Sustained contraction of body muscles, spasms, lock jaw, unconsciousness, opisthotonus & Risus Sardonicus - Stretching of facial muscles & neck-back muscles.

S.No.	Viral Diseases	Pathogen	Symptoms & Pathogenicity
(1)	Common cold	***Rhino*** viruses (Group of viruses) (ss RNA)	• One of the most infectious human ailments • Transmits through droplet resulting from cough, sneeze etc. • Infect nose and respiratory passage but not the lungs • Nasal congestion and discharge, sore throat, hoarseness, cough, headache, tiredness
(2)	Chikun-gunya	***Chikungunya*** virus (ss-RNA) (Vector :- ***Aedes-ageypti*** mosquito)	• Fever, joint pain, Lymphoadenopathy (enlargement of lymph nodes)
(3)	Dengue fever or Break-bone-fever	***Flavi-arbo*** virus (Vector :- ***Aedes-ageypti*** mosquito)	• Fever, severe-frontal-headache, muscle & joint pain • Bleeding from nose, mouth, gums
(4)	Hepatitis-B	HBV (ds DNA)	• Severe liver damage, jaundice • Recombinant DNA-vaccine • Transmits-through parenteral and sexual-route • Can cross placenta

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Common diseases in humans protozoan diseases :

Malaria:

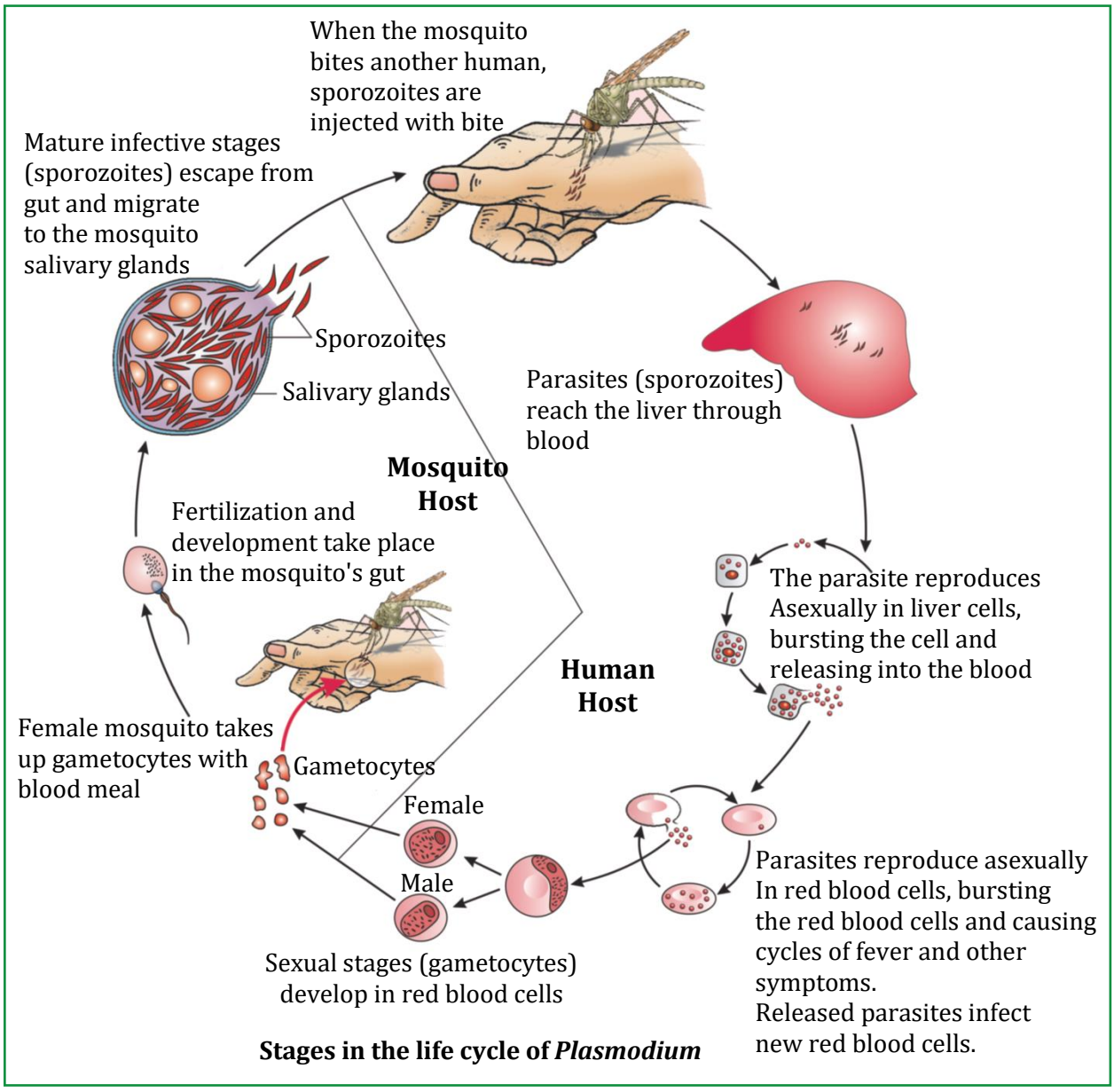
Pathogen :

- *Plasmodium (a tiny protozoan)*
- Different species of *Plasmodium* (*P. vivax*, *P. malariae* and *P. falciparum*) are responsible for different types of malaria.
- Of these, malignant malaria caused by *Plasmodium falciparum* is the most serious one and can even be fatal.

Symptoms : Fever and Chills

Stages in the life cycle of *Plasmodium* :

- It requires two hosts – human and mosquito – to complete its life cycle.
- The female *Anopheles* mosquito is the vector (transmitting agent) too.


When the mosquito bites another human, sporozoites are injected with bite
Mature infective stages (sporozoites) escape from gut and migrate to the mosquito salivary glands
Sporozoites
Salivary glands
Parasites (sporozoites) reach the liver through blood
Mosquito Host
Fertilization and development take place in the mosquito's gut
The parasite reproduces Asexually in liver cells, bursting the cell and releasing into the blood
Human Host
Female mosquito takes up gametocytes with blood meal
Gametocytes
Female
Male
Parasites reproduce asexually In red blood cells, bursting the red blood cells and causing cycles of fever and other symptoms.
Released parasites infect new red blood cells.
Sexual stages (gametocytes) develop in red blood cells

Stages in the life cycle of *Plasmodium*

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SOME PROTOZOANAL DISEASE

	Protozoanal Disease	Pathogen	Symptoms & Pathogenicity
(1)	Amoebiasis (Amoebic dysentery)	***Entamoeba histolytica***	• Parasite in large intestine • Constipation, abdominal pain and cramps • Stools with excess mucus and blood clots • Houseflies acts as mechanical carriers • Spreads through contaminated food and water

SOME HELMINTHIC DISEASES

	Helminthic Disease	Pathogen	Symptoms & Pathogenicity
(1)	Ascariasis	***Ascaris*** (Common Round worm)	• Intestinal parasite • Internal bleeding, muscular pain, fever, anemia, blockage of the intestinal passage • Eggs of the parasite excreted along with the faeces of infected person which contaminate soil, water, plants
(2)	Elephantiasis (Filariasis)	***Wuchereria (W. bancrofti and W. malayi)*** (Filarial worm)	• Slowly developing chronic inflammation of the organs in which they live for many years **(Usually the lymphatic vessels of the lower limbs)** • Genital organs are also often affected, resulting gross deformities • Transmitted to a healthy person through the bite by the female mosquito vectors

SOME FUNGAL DISEASE

	Fungal Disease	Pathogen	Symptoms & Pathogenicity
(1)	Ringworms	***Microsporum Trichophyton & Epidermophyton***	• One of the most common infectious disease • Appearance of dry, scaly lesions on various parts of the body such as skin, nails and scalp. • These lesions are accompanied by intense itching • Heat and moisture help these fungi to grow, which makes them thrive in skin folds such as those in the groin or between the toes • Generally acquired from soil or by using towels, clothes or even the comb of infected individuals

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Diagram showing inflammation in one of the lower limbs due to elephantiasis

Diagram showing ringworm affected area of the skin

4. Prevention and Control of Infectious Diseases :

(1) Prevention and control of food/water borne diseases such as typhoid, amoebiasis and ascariasis, etc.

Maintenance of personal and public hygiene :

- Measures for personal hygiene
- Keeping the body clean
- Consumption of clean drinking water, food, vegetables, fruits, etc.
- Measures for public hygiene
- Proper disposal of waste and excreta
- Periodic cleaning and disinfection of water reservoirs, pools, cesspools and tanks
- Observing standard practices of hygiene in public catering

(2) Prevention and control of air borne diseases such as pneumonia and common cold, etc.

- In addition to the previous measures, close contact with the infected persons or their belongings should be avoided.

(3) Prevention and control of diseases such as malaria and filariasis, etc. that are transmitted through insect vectors

To control or eliminate the vectors and their breeding places, which can be achieved by :

- Avoiding stagnation of water in and around residential areas
- Regular cleaning of household coolers
- Use of mosquito nets
- Introducing fishes like Gambusia in ponds that feed on mosquito larvae
- Spraying of insecticides in ditches, drainage areas and swamps, etc
- Providing doors and windows with wire mesh to prevent the entry of mosquitoes

Such precautions have become more important especially in the light of recent widespread incidences of the vector-borne (*Aedes* mosquitoes) diseases like dengue and chikungunya in many parts of India.

The advancements made in biological science which have armed us to effectively deal with many infectious diseases

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- Discovery of antibiotics and various other drugs has also enabled us to effectively treat infectious diseases.
- The use of vaccines and immunisation programmes have enabled us to completely eradicate a deadly disease like smallpox, and to control other infectious diseases like polio, diphtheria, pneumonia and tetanus to a large extent.
- Biotechnology is at the verge of making available newer and safer vaccines.

BEGINNER'S BOX-1 ACQUIRED DISORDERS, IMMUNITY

1. Health includes :-
(1) Complete physical well being (2) Complete mental well being
(3) Complete social well being (4) All of the above

2. Who asserted good humor hypothesis?
(1) Hippocrates (2) Indian Ayurveda system
(3) William Harvey (4) Both (1) and (2)

3. Good humor hypothesis was disproved by demonstration of normal body temperature in persons with –
(1) Blood (2) Phlegm (3) Yellow bile (4) Black bile

4. Health is affected by –
(1) Food and water we take (2) Rest and exercise we give to our bodies
(3) Habits that we have or lack (4) All of the above

5. Which of the following is incorrect in context of diseases?
(1) Functioning of one or more organs is adversely affected
(2) Characterised by appearance of various signs and symptoms
(3) Broadly grouped into infectious and non-infectious
(4) AIDS is one of the non-infectious diseases

6. Disease causing organisms are called –
(1) Parasites (2) Vectors (3) Pathogens (4) Carriers

7. Lips and finger nails may turn gray to bluish in colour in severe cases of –
(1) Typhoid (2) Pneumonia (3) Dysentery (4) Common cold

8. The malignant malaria is caused by :-
(1) P. vivax (2) P. malaria (3) P. falciparum (4) All

9. The fungi causing ringworm disease are :-
(1) Microsporum (2) Trichophyton (3) Epidermophyton (4) All of the above

10. Pick wrong one out :-
(1) Elephantiasis – Wuchereria
(2) Amoebic dysentery – Entamoeba histolytica
(3) Infective stage of Plasmodium for human – Sporozoite
(4) Pneumonia – Salmonella typhi

11. Which of the following is a non-infectious disease?
(1) Common cold (2) Cancer (3) Malaria (4) Cholera

12. "Fluid filled alveoli" are feature of :-
(1) Amoebiasis (2) Pneumonia (3) Ascariasis (4) Typhoid

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13. Sexual stages in the life cycle of Plasmodium are developed in –
(1) Liver of human (2) Red blood cells of human
(3) Gut of mosquito (4) Salivary gland of mosquito

14. The vector for pathogen of malaria is –
(1) Male Anopheles mosquito (2) Female Anopheles mosquito
(3) Aedes mosquito (4) Culex mosquito

15. Which of the following is a protozoan dysentery?
(1) Malaria (2) Shigellosis (3) Amoebiasis (4) Diphtheria

5. Immunity :

(1) Immunity : Resistance of the body against a pathogen or disease.

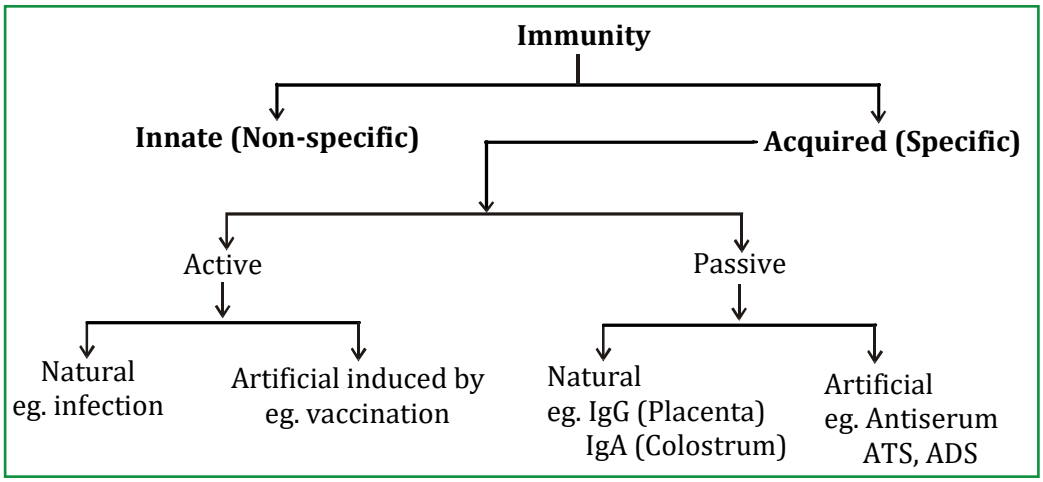
(2) Antigen or Agglutinogen : Substance which **stimulates** the production of antibodies.

(3) Antibody or Agglutinin : It is a complex glycoprotein **secreted by B-lymphocytes** in response to an antigen.

(4) Antiserum : Serum of any animal which **contains the antibody** for a specific antigen is called antiserum.

(5) Venom (poison) : Toxic substances secreted by animals and some insects.

(6) Agglutination : Antigen antibody reaction is called agglutination and study of antigen-antibody reaction is called **serology**.



- Overall ability of the host to fight the disease-causing organisms or resistance of the body against a disease is called immunity.
- Immunity is conferred by the immune system.

Classification of immunity :

- Immunity is of two types :

Innate Immunity	Acquired Immunity
• Pathogen non-specific type of defence • Present at the time of birth (Inborn/ Congenital) • Not characterised by memory • Found in plants and animals both • It includes monocytes, neutrophils, NK cells and macrophages	• Pathogen specific type of defence • Acquired during life (Adaptive) • Characterised by memory • Found in higher vertebrates only • It includes T-lymphocytes and B-lymphocytes

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Innate immunity:

- Innate immunity is accomplished by providing different types of barriers to the entry of the foreign agents into our body.
- Innate immunity consists of four types of barriers :
  (1) Physical barriers
  (2) Physiological barriers
  (3) Cellular barriers
  (4) Cytokine barriers

(1) Physical barriers of innate immunity

Following structures are included in these barriers :

(A) Skin

- Skin on our body is the main barrier which prevents entry of the micro-organisms into our body.
- Outermost layer of skin (Stratum corneum) is dead, so the bacteria do not grow or enter into it.
- pH of skin is acidic (3-5) in nature, destroys the bacteria.

(B) Mucosa

- Mucus coating of epithelium lining of the respiratory, gastrointestinal and urogenital tracts also act as physical barriers for microbes entering our body.
- Mucosa contain mucosal cells and cilia.
- Mucous secreted by mucosal cells and cilia help in trapping and propelling the microbes respectively.

(2) Physiological barriers of innate immunity

- Fever, acidic pH of various body parts (like oral cavity, stomach and vagina) and secretions containing lysozyme enzyme (like tears, sebum) are included in this type of barrier.
- Acid in the stomach, saliva in the mouth, tears from eyes all prevent microbial growth.
- Some physiological processes of body create adverse environment for growth of bacteria.

(3) Cellular barrier of innate immunity

There is involvement of two types of cells :

(A) Phagocytic Cells

- These cells perform phagocytosis.
- Examples of phagocytic cells are :
- **In blood :** Polymorpho-nuclear leukocytes (PMNL- neutrophils), Monocytes
- **In tissues :** Macrophages

Note : Monocytes are liberated at the site of infection and later converted into macrophages.

(B) Non-Phagocytic Cells

- These cells do not perform phagocytosis.
- Example of non-phagocytic cells is Natural Killer cell or NK cell.
- NK cell kills abnormal cell by creating perforin lined pores in the plasma membrane. Water enters through these pores causing swelling and bursting of the abnormal cell.

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(4) Cytokine barrier of innate immunity

- It includes interferons.
- Interferons are antiviral proteins, secreted by virus infected cells.
- Interferons are chemically **glycoproteins**, each molecule consisting of 270 amino acids.
- Interferons protect non-infected cells from further viral infection by stimulating the adjacent normal cells to produce **Translational Inhibiting Protein (T.I.P.).**
- Interferons are not virus specific, but are species specific.
- α-interferon is given to AIDS patients to treat **Kaposi sarcoma**, it acts as **Biological Response Modifier**.
- β-interferon is given for slow progression of multiple sclerosis (an auto immune disorder)
- γ-interferon is secreted by certain lymphocytes like NK cells and T- Killer cells.
- Now a days, interferons are produced by genetic engineering also.

Inflammation : Local response of living mammalian tissue to injury due to any agent. It is the body's defence reaction in order to eliminate or limit the spread of infectious agent.
Inflammation is characterised by –

- **Redness (Rubor/Erythema)** – due to vasodilation.
- **Heat (Calor)** – metabolic reactions proceed more rapidly.
- **Swelling (Tumor)** – due to increased permeability of blood vessels.
- **Pain (Dolor)** – results from injury to neurons and chemicals released by damaged cells (e.g. prostaglandins).

(A) Acquired Immunity :

- Acquired immunity was evolved in higher vertebrates.

Characteristics:

- **Specificity :** Pathogen specific type of defence
- **Diversity :** Recognition of vast variety of pathogens (antigens)
- Discrimination between self cells & foreign organisms (**e.g.** pathogens/foreign molecules) : Present
- **Memory :** Present

3R's of acquired immunity:

Recognition – Response – Remember

Immune responses and role of memory:

Encounter of body with a pathogen (antigen)	Immune response by body	Onset and intensity of immune response
First	Primary (PIR)	Slow and low
Subsequent	Secondary / Anamnestic (SIR)	Rapid and high (due to memory of first encounter of body with same pathogen)

- Low intensity of immune system : Antibody concentration = Low
- High intensity of immune system : Antibody concentration = High

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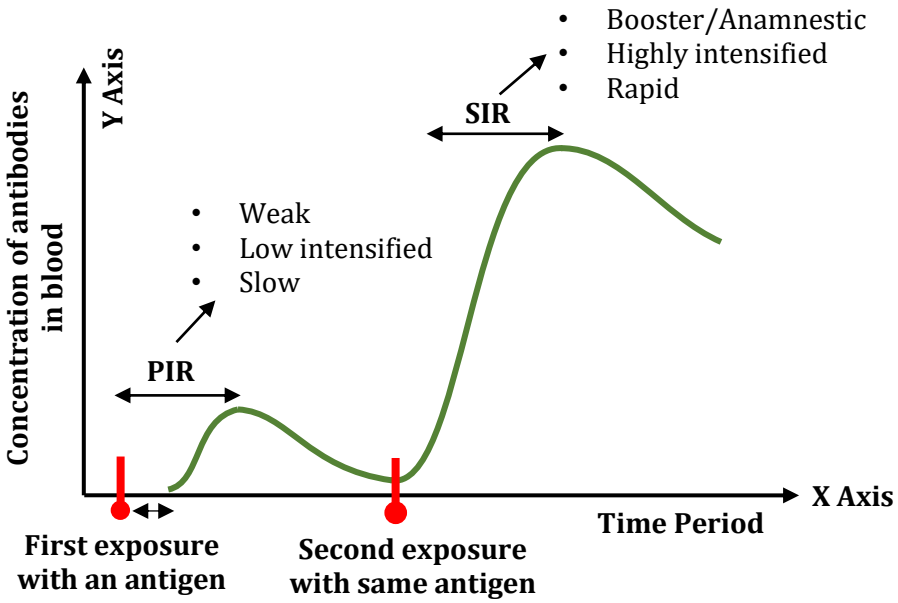
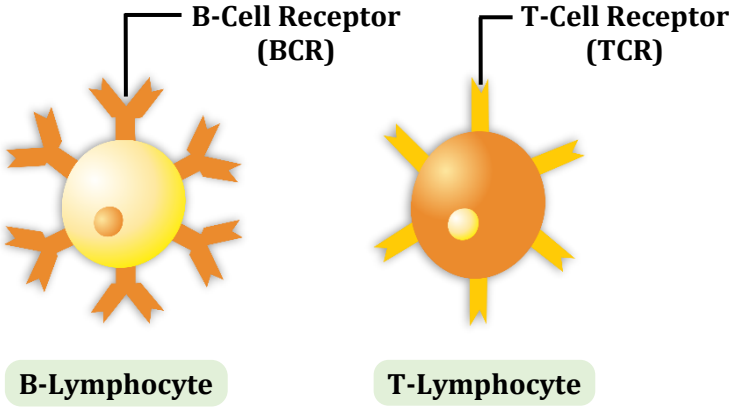
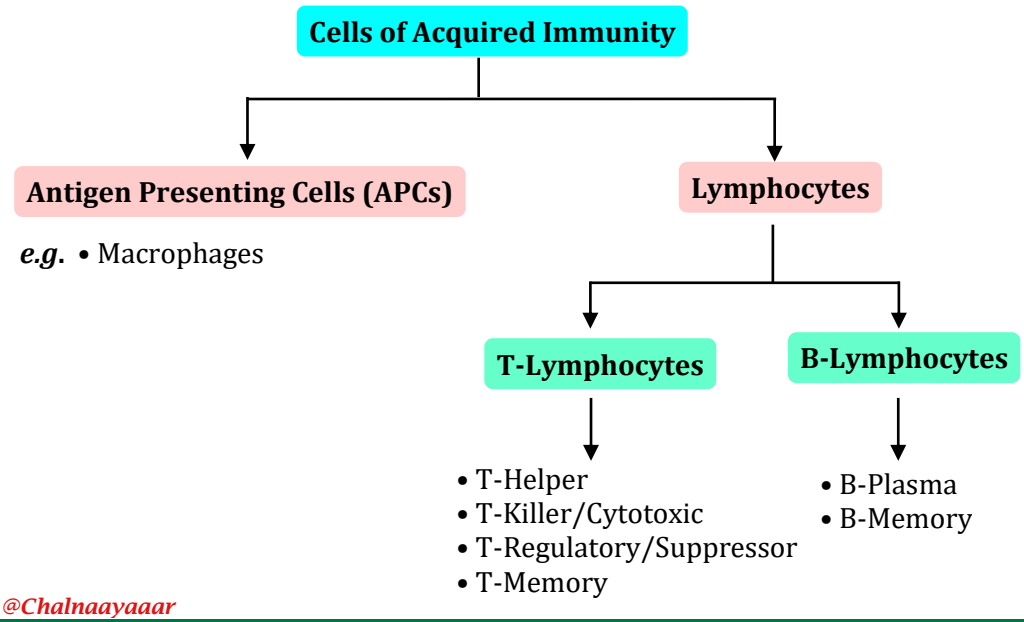


(B) Cells of Acquired Immunity :

- The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood, **i.e.**, B-lymphocytes and T-lymphocytes.
- The B-lymphocytes produce an army of proteins in response to pathogens into our blood to fight with them. These proteins are called antibodies.



- The T-cells themselves do not secrete antibodies but help B cells to produce them.



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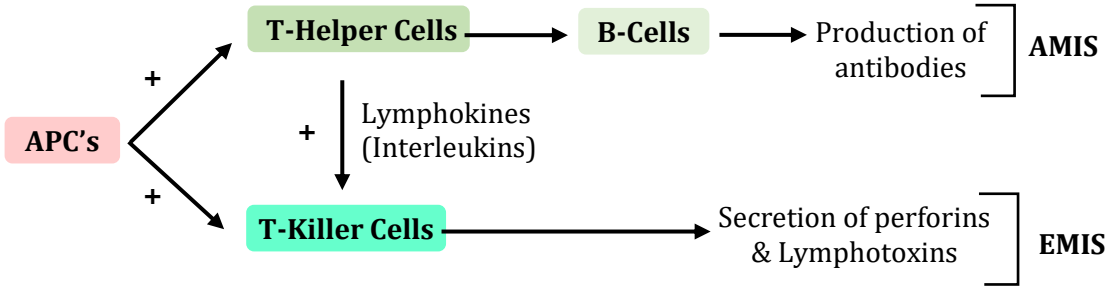
Mechanism of acquired immunity :



Lines of Defence :

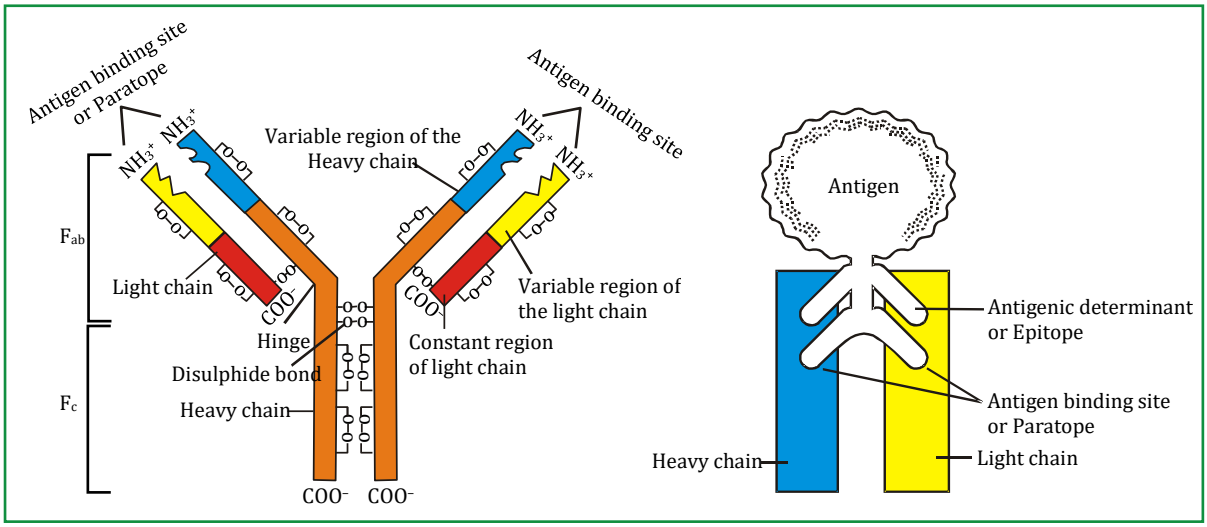
- First line of defence : Skin, Mucous membrane
- Second line of defence : Neutrophils, Monocytes, Macrophage, Interferon, Fever.
- Third line of defence : Specific immunity by T- and B-lymphocytes

Antigen (Ag):

- Antigen is the substance which stimulates antibodies production.
- Most of antigens are proteins.
- Each antigen molecule has different antigenic determinant sites (epitopes), which are recognised by antibodies or B/T lymphocytes.

(C) Antibody (Ab)/ Immunoglobulin (Ig) :

- Antibody is a complex glycoprotein molecule, secreted by plasma B lymphocytes.
- Each antibody molecule has four polypeptide chains, two small called light chains and two longer called heavy chains, held together by interchain disulphide bonds in shape of Y.
- It is represented as H_2L_2.



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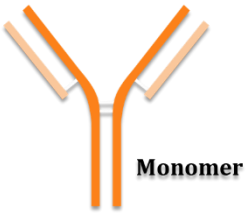
Different types (classes) of antibodies are produced in our body :

1. IgG antibody

- Most abundant
- About 75% of total antibodies in blood
- Can cross placenta
- Provides natural passive acquired immunity to foetus

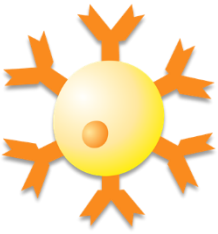


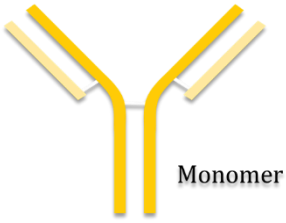
2. IgA antibody

- Second most abundant (about 10%)
- Dimer antibody
- Secretory antibody
- Present in saliva, tears, sweat, mucus
- Protects mucosal lining (inhaled pathogen)
- Also present in colostrum (Natural passive acquired immunity to infants)

3. IgD antibody

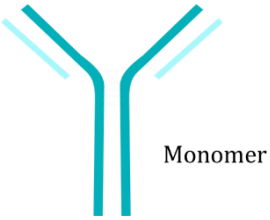
- Fixed or surface antibody
- Acts as B cell receptor (BCR)





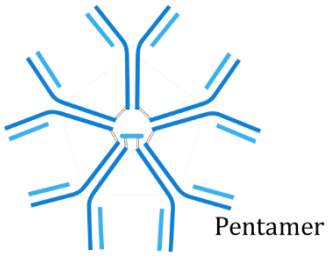
4. IgE antibody

- Present in very small quantity (0.05%)
- Involved in allergy (type 1 hypersensitivity)
- Stimulates mast cells and basophils
- Also protects from parasitic infections



5. IgM antibody

- Pentamer antibody
- Largest antibody
- Millionaire or heaviest antibody (M.W. = 9,60,000)
- Oldest antibody
- First antibody formed by foetus by the age of 5 months against congenital infections during intrauterine life.



Different functions of antibodies are :

1. Agglutination

- Antibody is attached with the antigen, present on the surface of pathogen and in turn destroy the pathogen by cell lysis.

2. Opsonisation

- Coating of bacteria (Ag) with opsonin antibody (IgG and IgM) facilitates the phagocytes cells and these antibodies or opsonins promote phagocytosis by combination with antigen.

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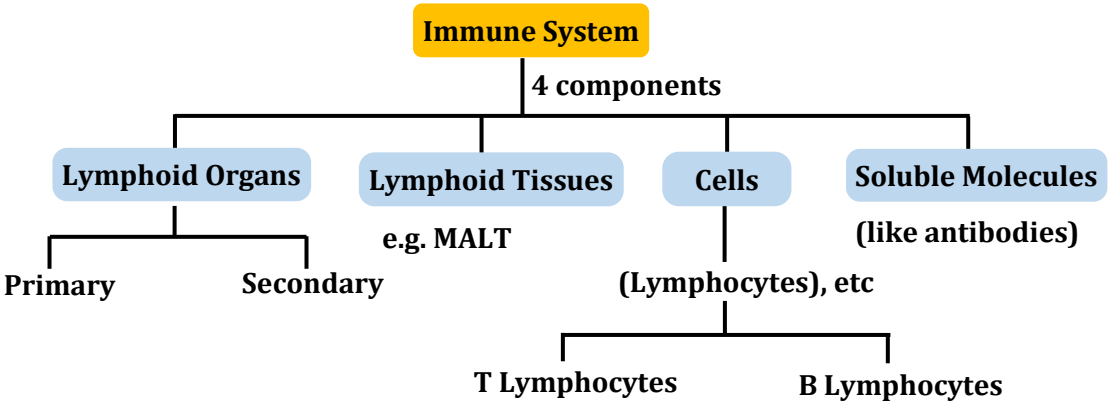
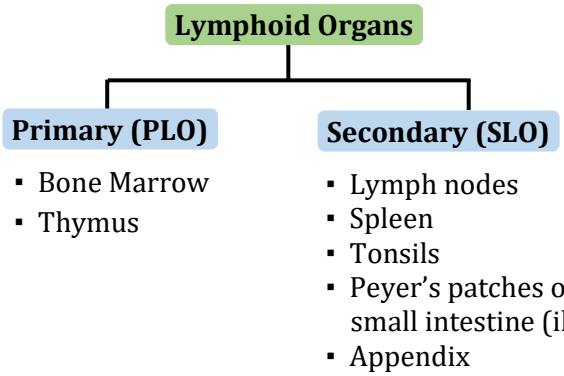
3. Neutralisation

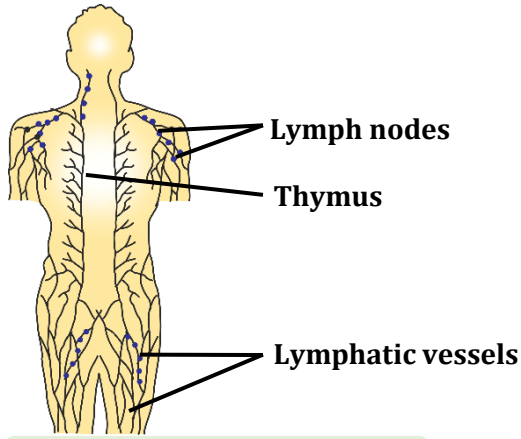
- Antibodies neutralize the viruses or toxin of bacteria by attaching with them.

(D) Immune System in the Body :



Examples of lymphoid organs:





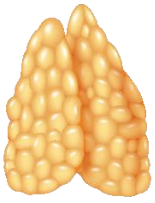
Diagrammatic representation of Thymus and Lymph nodes

Bone Marrow:

- Main lymphoid organ where all blood cells including lymphocytes are produced

Thymus:

- A lobed organ located near the heart and beneath the breastbone.
- Quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size



Note : Both bone-marrow and thymus provide **micro-environments** for the development and maturation of T-lymphocytes.

Spleen:

- A large bean shaped organ
- Mainly contains lymphocytes and phagocytes
- Acts as a filter of the blood by trapping blood-borne microorganisms
- Also has a large reservoir of erythrocytes

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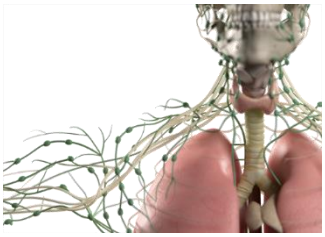
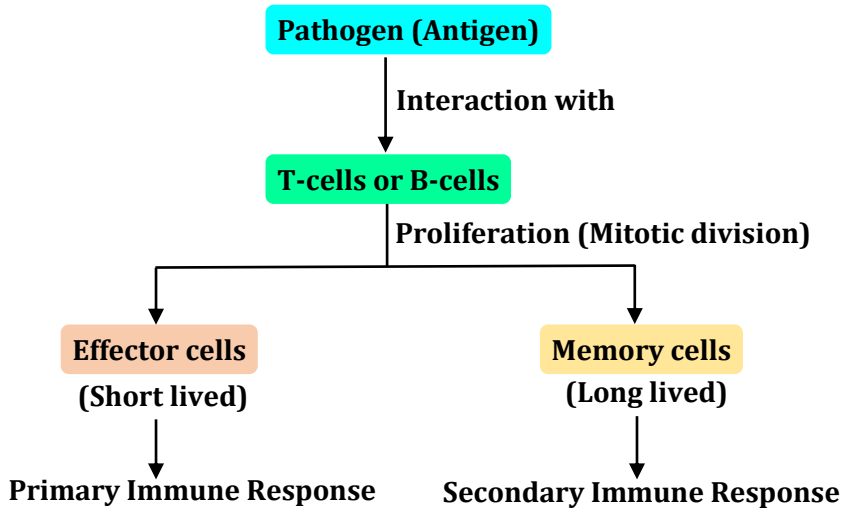
Lymph nodes:



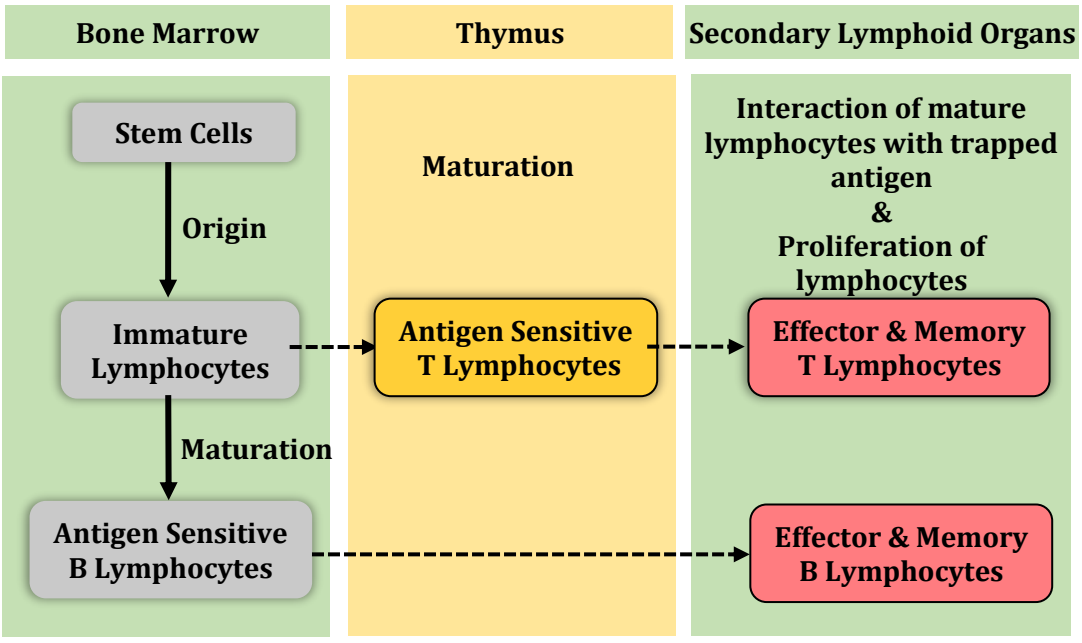
- Small solid structures located at different points along the lymphatic system.
- Serve to trap the micro-organisms or other antigens, which happen to get into the lymph and tissue fluid.

MALT:

- MALT= Mucosa Associated Lymphoid Tissue
- It is lymphoid tissue located within the lining of the major tracts (respiratory, digestive and urogenital tracts).
- **It constitutes about 50 per cent of the lymphoid tissue in human body.**



Note : Effector B cells are also known as Plasma B cells.



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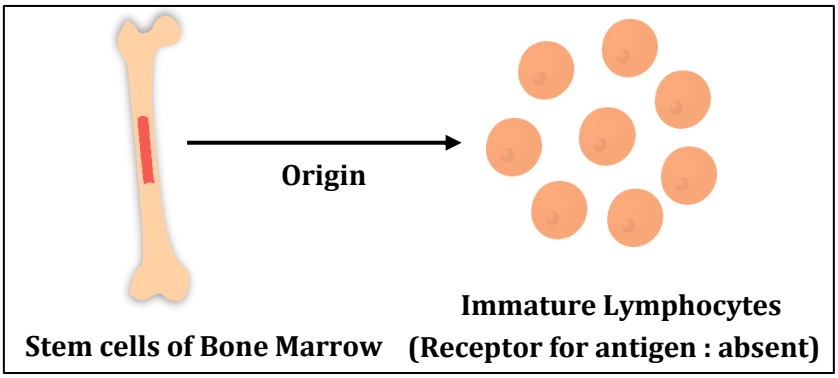
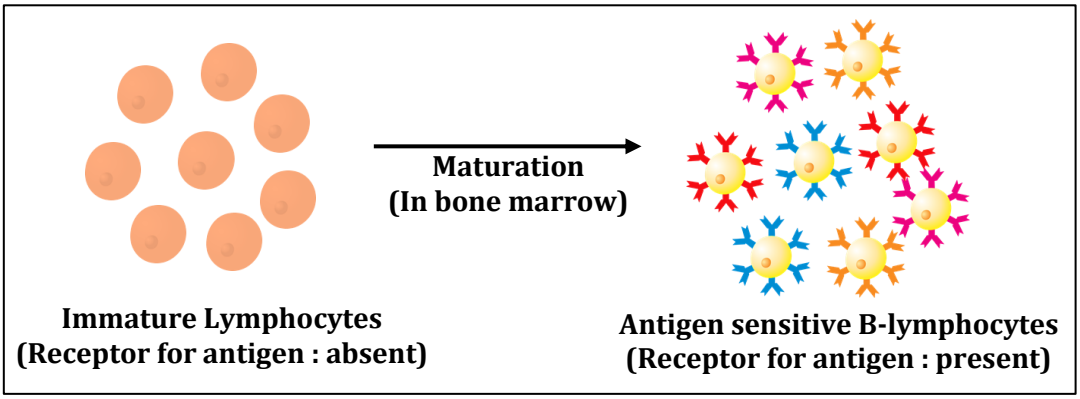
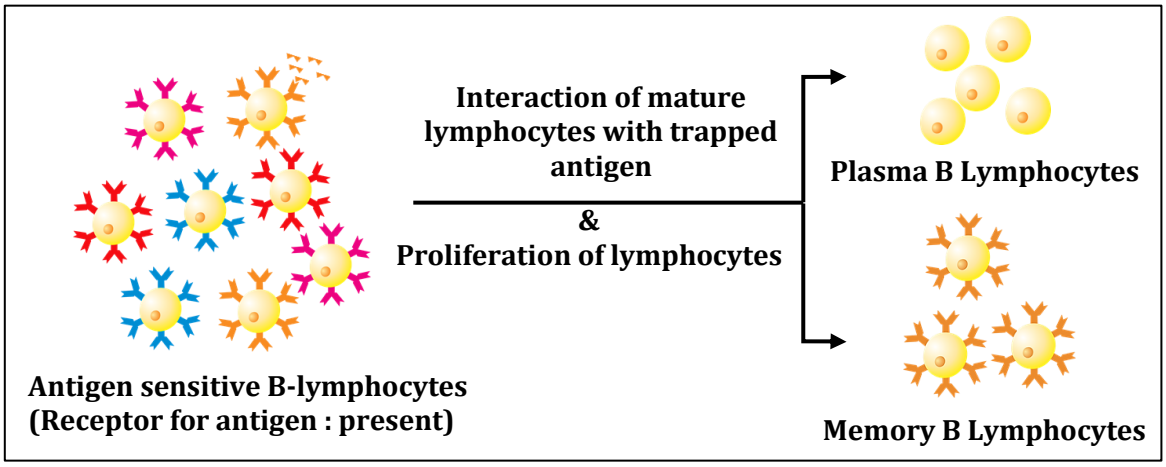
Origin, maturation and proliferation of B Lymphocytes







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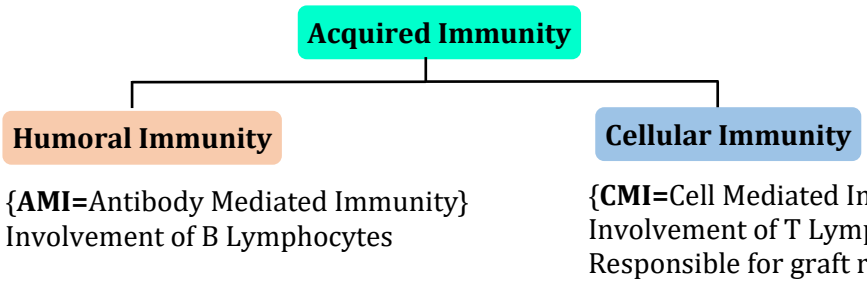
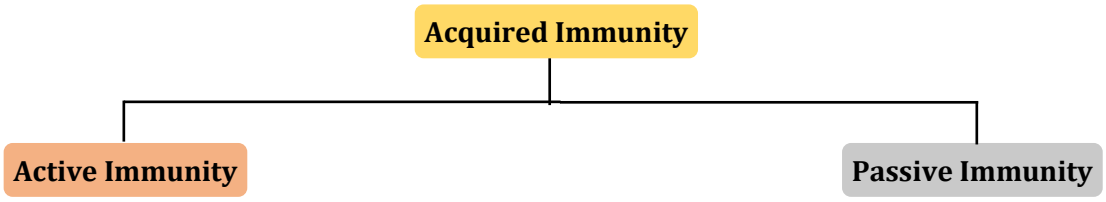
Types of Acquired Immunity:

1. On the basis of involvement of type of lymphocytes :



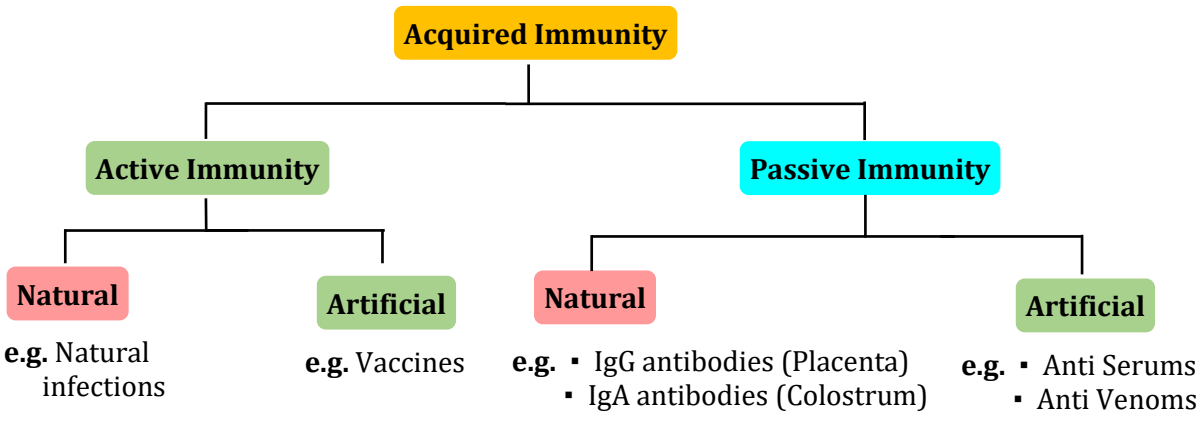
2. On the basis of participation of immune system of host :



- Active participation of immune system of host
- Antibodies are produced against living/dead microbes or other proteins
- Slow response
- Immunological memory- Present
- Serves no purpose in immuno-deficient host
- Used for prophylaxis to increase body resistance

- No participation of immune system of host
- Readymade antibodies are received by/ administered to host
- Quick response
- Immunological memory- Absent
- Applicable in immuno-deficient host
- Used for treatment of acute infection

Examples of Active and Passive Immunity



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BEGINNER'S BOX-2 IMMUNITY

1. The light chain and heavy chain of antibody are joined with the help of :-
(1) H–H bond (2) S–S bond (3) Ionic bond (4) Phosphodiester bond

2. Colostrum is rich in :-
(1) IgA (2) IgG (3) IgE (4) IgM

3. Fever, pH and body secretions are included in which of the following barrier :-
(1) Physical (2) Cellular (3) Cytokine (4) Physiological

4. Which of the following are the properties of acquired immunity ?
(1) Specificity (2) Diversity
(3) Immunological memory (4) All of the above

5. Which of the following is true about immunity?
(1) It is overall ability of the host to fight the disease causing organisms
(2) It is resistance of the body against a disease
(3) It is conferred by immune system
(4) All of the above

6. Innate immunity is –
(1) Pathogen non-specific type of defence
(2) Present at the time of birth
(3) Not characterised by memory
(4) All of the above

7. Acquired immunity is not –
(1) Pathogen specific type of defence (2) Present at the time of birth
(3) Characterised by memory (4) All of the above

8. Which of the following barriers of innate immunity includes skin on our body?
(1) Physical barriers (2) Physiological barriers
(3) Cellular barriers (4) Cytokine barriers

9. Physiological barriers do not include –
(1) Acid in the stomach
(2) Saliva in the mouth
(3) Tears from eyes
(4) Mucus coating of the epithelium lining different tracts

10. Natural killer cells are a type of –
(1) Erythrocytes (2) Monocytes (3) Lymphocytes (4) Thrombocytes

11. Interferons are included in –
(1) Physical barriers of innate immunity
(2) Physiological barriers of innate immunity
(3) Cellular barriers of innate immunity
(4) Cytokine barriers of innate immunity

12. Interferons –
(1) Are secreted by non-infected cells (2) Protect virus infected cells
(3) Are lipids in nature (4) None of the above

13. Acquired immunity is present in –
(1) Lower vertebratesjdo (2) Higher vertebrates
(3) All vertebrates (4) No vertebrate

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14. Which of the following is not a characteristic of acquired immunity?
(1) It is a pathogen specific type of defence
(2) Only few certain pathogens can be recognised by it.
(3) Discrimination between self cells and foreign organisms is present in it.
(4) It has immunological memory.

15. Which of the following is an example of antigen presenting cells?
(1) T-Killer lymphocyte (2) T-Helper lymphocyte
(3) Macrophage (4) Natural Killer cell

16. Which of the following classes of antibodies can cross placenta?
(1) IgG (2) IgA (3) IgM (4) IgD

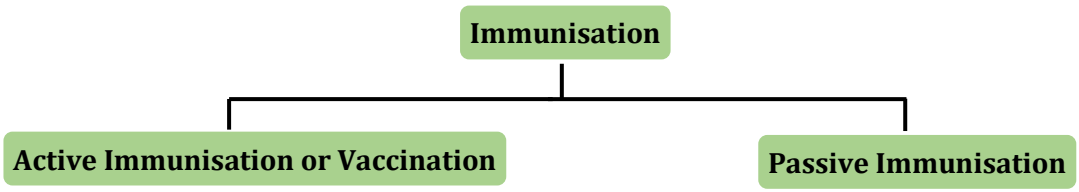
17. Which of the following is/are not secondary lymphoid structure(s)?
(1) Spleen (2) Lymph nodes (3) Bone marrow (4) Tonsils

18. Which of the following organs provide micro-environments for the development and maturation of T-lymphocytes?
(1) Bone marrow (2) Thymus (3) Both (1) and (2) (4) None of the above

19. MALT constitutes about …….. per cent of the lymphoid tissue in human body. Which one of the following options is correct to fill in the blank?
(1) 20 (2) 50 (3) 80 (4) 99

20. Immature lymphocytes are –
(1) Lymphocytes on which receptors for antigens are absent
(2) Antigen sensitive lymphocytes
(3) Effector cells
(4) Memory cells

6. Immunisation :



(A) Active Immunisation/Vaccination :

- It is to provide (acquired) immunity artificially for a particular infection/disease by administration of vaccine.
- It provides prophylaxis for a particular infection/disease.

Vaccine :

- It is a preparation of weakened/inactivated pathogen, pathogenic exotoxins without toxicity or antigenic proteins of pathogen.
- Vaccines are taken orally or by injection to provide immunity for that pathogen.
- **Edward Jenner, 1796** (**Father of immunity**) noticed that milkmaid did not suffer from small pox but they had scabs of cow pox. He transport the material from sore of milkmaid who was suffering from cow pox to the young boy of 8 year old. After sometime he injected live small pox material into that boy. But symptoms of disease did not appear. He tried this procedure on other person and got success. He gave the term vaccination for this process.

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- **Louis Pasture :** He discovered the **process of inactivating the pathogen** & prepared vaccines for **Chicken cholera, Anthrax & Rabies**.
- **Von Behring :** He discovered the process of **passive immunization** and prepared the **antidiphtherial serum (ADS)** by injecting diphtheria antigen into sheep. Von Behring is known as **'Father of passive immunization'.**

Principle of Vaccination :

- Principle of vaccination is based on memory of immune system of host.

First encounter of body with antigens

Introduction of **vaccine (only antigens ; no pathogenicity/toxicity)** into the body

↓

Primary immune response

Slow recognition of antigens ;
Production of **low concentration of antibodies** by immune system of host against these antigens & generation of memory B- and T- cells

⇣ **In future**

Subsequent encounter of body with 'same' antigens

↓ (Actual infection)

Secondary immune response

Quick recognition of antigens; **massive production of antibodies** by immune system of host against these antigens
{due to memory of immune system of host}

Types of Vaccines :

- There are 4 different types of vaccines available :

Vaccine

- **Live Vaccine** — Complete pathogen : after attenuation / Natural
- **Killed Vaccine** — Complete pathogen : after inactivation
- **Toxoids Vaccine** — Pathogenic exotoxins without toxicity i.e. toxoids
- **Recombinant Antigen Vaccine** — Antigenic proteins of pathogens

Examples of Different Types of Vaccines :

1. Live (Natural/Atteneuated) Vaccines :

- Small Pox
- Rota virus
- BCG (Bacillus Calmette Guerin) : for tuberculosis
- OPV (Oral Polio Vaccine; Sabin type 1)
- MMR (Measles, Mumps, Rubella), etc.

2. Killed (Inactivated) Vaccines :

- IPV (Inactivated Polio Vaccine) / Salk Polio
- Whooping cough (Pertussis)
- TAB : for typhoid
- Rabies
- Influenza
- Pneumonia
- Cholera, etc.

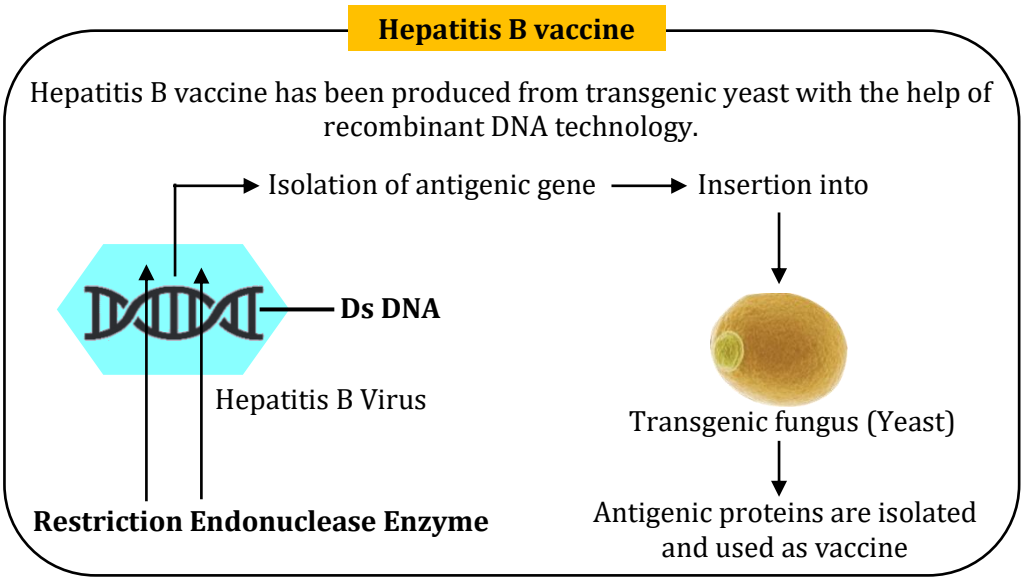
3. Toxoid Vaccines :

- Tetanus (TT)
- Diphtheria (DT)
- Botulism, etc.

4. Recombinant Antigen Vaccines :

- Hepatitis B

Live vaccines (Natural/Attenuated)	Killed Vaccines (Inactivated)	Toxoids Vaccines (Subunit Vaccine)	Recombinant Antigen Vaccines (Subunit Vaccine)
• Small pox • Rota virus • BCG (Bacillus Calmette Guerin) • OPV (Oral Polio Vaccine, Sabin Type 1) • MMR (Measles, Mumps, Rubella)	• Salk polio (IPV) • Whooping cough (Pertussis) • TAB for Typhoid • Rabies • Influenza • Pneumonia • Cholera	• Tetanus (TT) • Diphtheria (DT) • Botulism	• Hepatitis-B


Hepatitis B vaccine
Hepatitis B vaccine has been produced from transgenic yeast with the help of recombinant DNA technology.
Isolation of antigenic gene
Insertion into
Ds DNA
Hepatitis B Virus
Transgenic fungus (Yeast)
Restriction Endonuclease Enzyme
Antigenic proteins are isolated and used as vaccine

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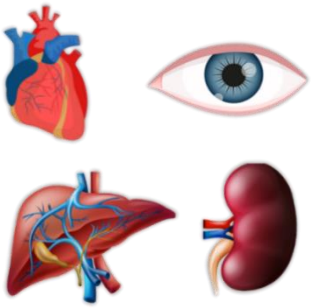
(B) Passive Immunisation :

- It is to provide immunity by administration of readymade antibodies (like antiserum, antivenom, antitoxin etc.).
- It provides treatment for an acute infection, snake bite, etc.
- There is no role of memory of immune system of host in passive immunisation.
- Common examples of antiserums are:
  - ✓ **ATS** = Anti Tetanus Serum
  - ✓ **ADS** = Anti Diphtherial Serum
  - ✓ **ARS** = Anti Rabies Serum, etc.

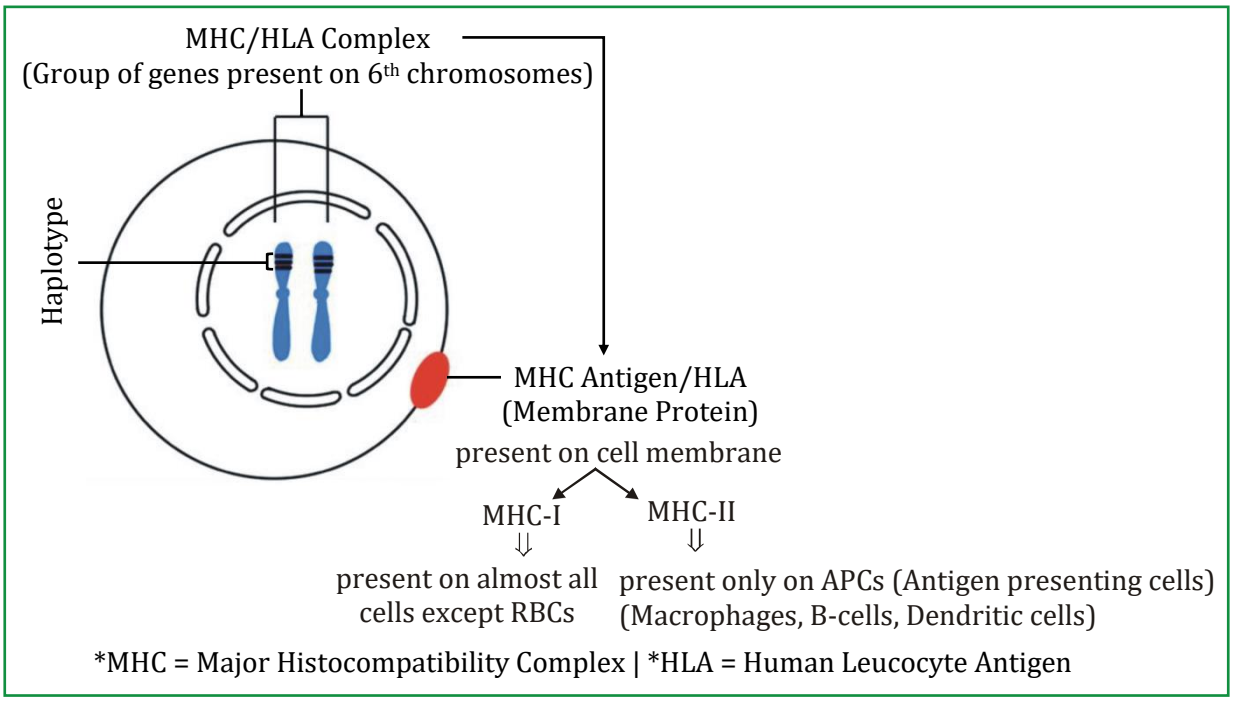
7. Transplantation :

- Graft = Transplanted tissue/organ
- Very often, when some human organs like heart, eye, liver, kidney fail to function satisfactorily, transplantation is the only remedy to enable the patient to live a normal life.
  A suitable donor? Why is it that the organs cannot be taken from just anybody?



- The body is able to differentiate 'self' and 'nonself'. Grafts from just any source an animal, another primate, or any human beings cannot be made since the grafts would be rejected sooner or later.
- The cell-mediated immune response is responsible for the graft rejection.
- Tissue matching, blood group matching are essential before undertaking any graft/transplant and even after this the patient has to take immuno- suppressants (e.g. Cyclosporin A, obtained from *Trichoderma polysporum* fungus) all his/her life.

Tissue matching/HLA or MHC Antigen matching :


MHC/HLA Complex
(Group of genes present on 6th chromosomes)
Haplotype
MHC Antigen/HLA
(Membrane Protein)
present on cell membrane
MHC-I
MHC-II
present on almost all cells except RBCs
present only on APCs (Antigen presenting cells) (Macrophages, B-cells, Dendritic cells)
*MHC = Major Histocompatibility Complex | *HLA = Human Leucocyte Antigen

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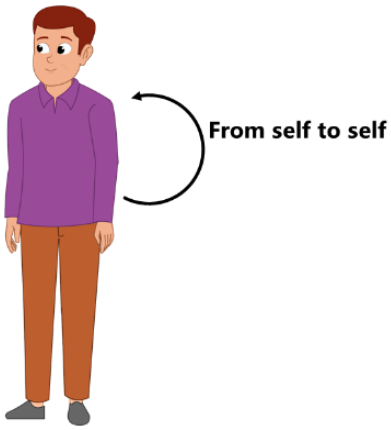
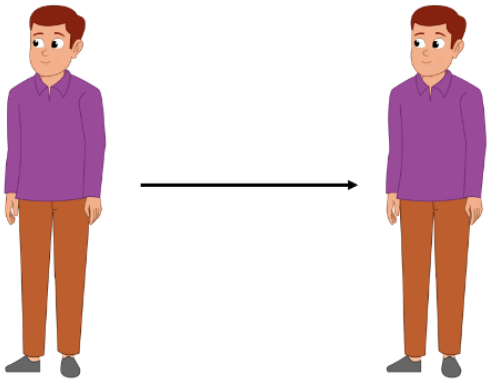
Types of Tissue Grafting :

1. Autograft



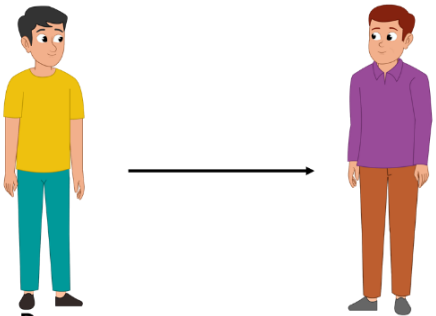
Donor/Recipient

2. Isograft (Syngraft)



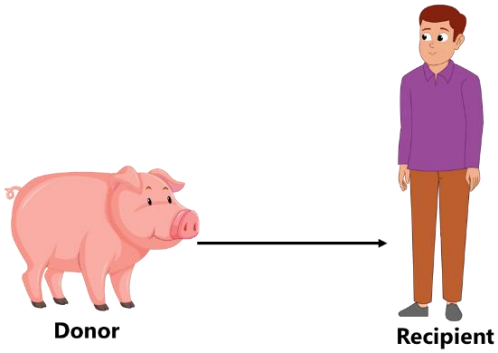
(Person with same genetic constitution)

3. Allograft



(Person of same species but with non identical genetic constitution)

4. Heterograft (xenograft)



(Individual of different species)

Successful graft order

Self > Identical twins > Siblings > Parents > Unrelated donors

BEGINNER'S BOX-3 — GRAFTING AND VACCINES

1. Vaccine is included in :-
(1) Natural passive acquired immunity
(2) Natural active acquired immunity
(3) Artificial active acquired immunity
(4) Artificial passive acquired immunity

2. MHC–II is present on :-
(1) Macrophage (2) B-lymphocytes (3) Dendritic cells (4) All of the above

3. Tissue matching is required in which of the following :-
(1) Homograft (2) Autograft (3) Allograft (4) Both (1) and (3)

4. 'BCG' vaccine is example of :-
(1) Killed vaccine (2) Live attenuated vaccine
(3) Toxoid (4) All of the above

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5. Which type of immunity is responsible for rejection of graft ?
(1) Innate immunity (2) Humoral immunity
(3) Antibody mediated immunity (4) Cell mediated immunity

6. HLA genes are present on –
(1) Chromosome 6 (2) Chromosome 8
(3) Chromosome 3 (4) Chromosome 12

7. Which of the following organs can be transplanted?
(1) Heart, Liver (2) Eye, Liver
(3) Pancreas, Lung (4) All of the above

8. Grafting from a donor of same specie but with non-identical genetic constitution to the recipient is called _____.
(1) autograft (2) Isograft
(3) allograft (4) heterograft

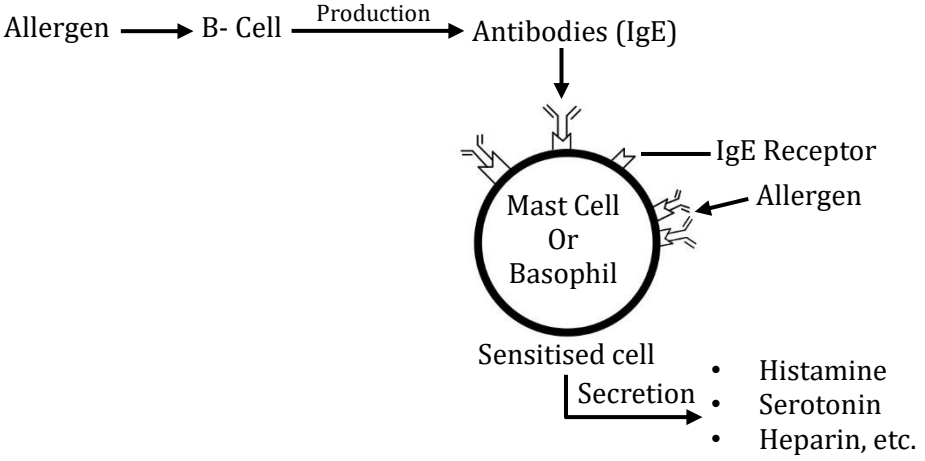
9. Principle of vaccination is based on –
(1) memory of immune system of host (2) memory of immune system of pathogen
(3) innate immune system (4) All of the above

10. Passive immunisation includes _____.
(1) Anti-tetanus serum (ATS) (2) Anti-diphtherial serum (ADS)
(3) Anti-rabies serum (ARS) (4) All of the above

8. Immune System Disorders :

(1) Allergies :

- When someone has gone to a new place and suddenly he/she started sneezing, wheezing for no explained reason, and when he/she went away, his/her symptoms disappeared. What did this happen to his/her?
- **Allergy :** Exaggerated (hypersensitive) response of the immune system to certain antigens present in environment.
- The substances to which such an immune response is produced are called allergens. Common examples of allergens are mites in dust, pollens, animal dander, etc.
- Symptoms of allergic reactions : Sneezing, watery eyes, running nose and difficulty in breathing, etc.



The Stages of Allergic Reaction

- The antibodies produced to these are of IgE type.
- Allergy is due to the release of chemicals like histamine and serotonin from the mast cells.
- The use of drugs like anti-histamine, adrenalin and steroids quickly reduce the symptoms of allergy.
- For determining the cause of allergy, the patient is exposed to or injected with very small doses of possible allergens, and the reactions studied.

Common examples of allergies :

(A) Bronchial asthma :

- It is an allergy of lower respiratory tract (lungs).

It is characterised by :

- Spasm of the smooth muscles present in the walls of the bronchi and bronchiole
- Secretion of excess amount of mucous by mucous membranes on the wall of the air passage, etc.

Symptoms :

- Coughing
- Difficulty in breathing mainly during expiration (Wheezing)

Prevention and care :

- To avoid exposure to the foreign substance or allergens
- Antibiotic therapy for removing the infection, and use of bronchodilator drugs as well as inhalers for symptomatic relief

(B) Hay fever :

- It is an allergy of mainly mucosa of eyes and upper respiratory passage.
- It is mainly due to pollen grains.

(C) Anaphylactic shock :

- It is generalised or most severe form of allergy.
- It involves almost all tissues of the body.
- It occurs within few minutes of entry of an allergen such as penicillin into blood.
- Histamine released from mast cells causes marked dilation of all arteries, therefore a large amount of fluid is passed from blood to the tissues and there is a drastic fall in blood pressure.
- Drastic **fall in blood pressure** may lead to unconsciousness and even death.

More and more children in metro cities of India suffer from allergies and asthma. Why?

(2) Auto Immunity :

- Sometimes, due to genetic and other unknown reasons, the body attacks self-cells. This results in damage to the body and is called auto-immune disease.

Rheumatoid arthritis which affects many people in our society is an auto-immune disease.

Hands that are deformed by rheumatoid arthritis

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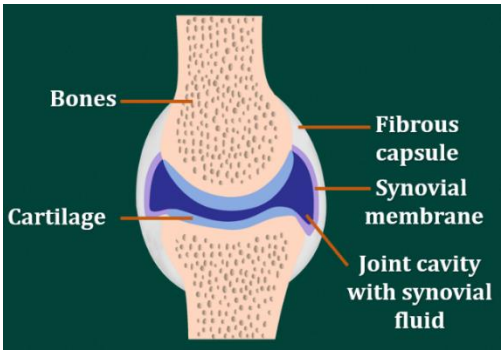

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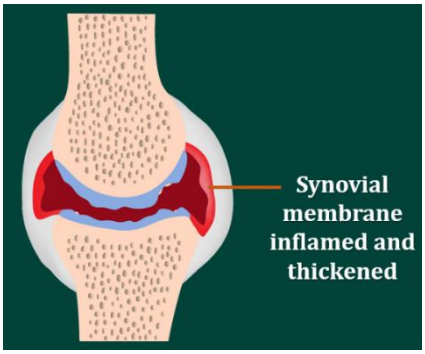

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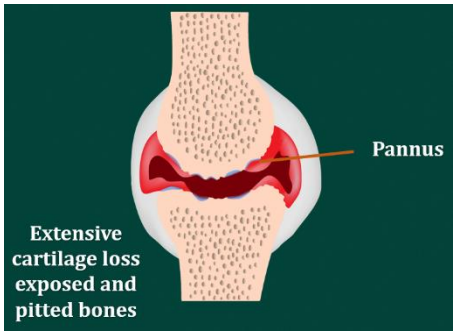

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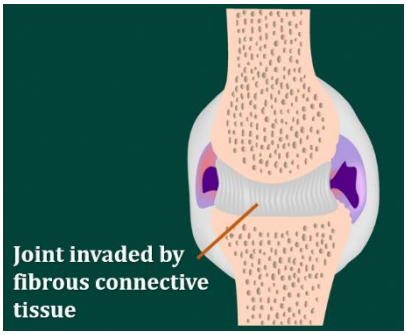

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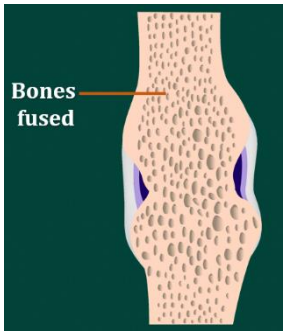

(5)

- It is due to formation of rheumatoid factor (IgM/IgG antibodies).
- The primary symptom of rheumatoid arthritis is inflammation of synovial membrane and pain due to pressure exerted by increased synovial fluid. If it is left untreated, finally the joint becomes immovable.
- Treatment of pain and inflammation is heat therapy and physiotherapy. Joint replacement is done in extreme cases.

Other examples of auto-immune disorders are :

- Myasthenia gravis
- Pernicious anaemia
- Insulin Dependent Diabetes Mellitus (IDDM)/ Type 1 Diabetes
- Hashimoto disease
- Multiple Sclerosis.

(A) Myasthenia Gravis

- In this autoimmune disorder, antibodies are formed against acetylcholine (Ach) receptors present on post synaptic membrane.
- It destroys acetylcholine receptors and causes depressed nerve conduction at neuromuscular junction and decreased movements of muscles.
- **Symptoms :** Weakening and finally degeneration of skeletal muscles.

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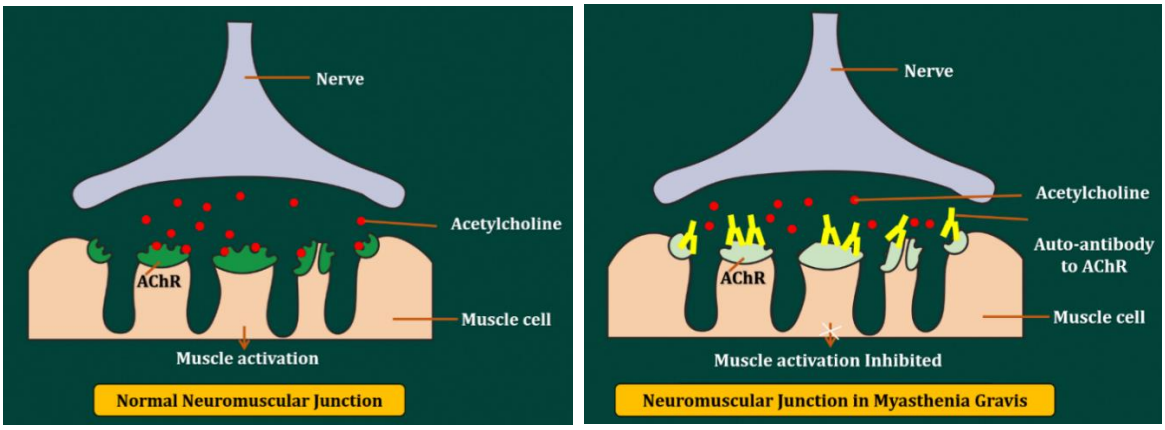
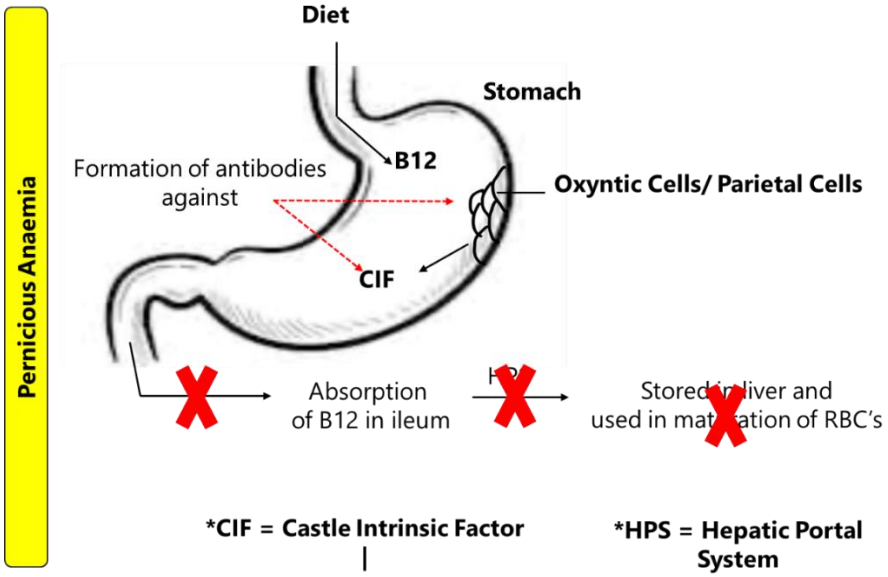


(B) Pernicious Anaemia

- In this autoimmune disease, antibodies are formed against gastric oxyntic cells and Castle Intrinsic Factor (CIF).
- Due to which vitamin B12 is not absorbed in the intestine and blood (RBC) formation is decreased.



(C) Insulin Dependent Diabetes Mellitus/Type 1 Diabetes

- In this autoimmune disease, antibodies are formed against β cells of pancreas.
- It destroys these cells and causes deficiency of insulin hormone in body.
- **Symptoms :** Hyperglycaemia, glycosuria, polyuria, polydipsia (excessive thirst), polyphagia (increased hunger), etc.

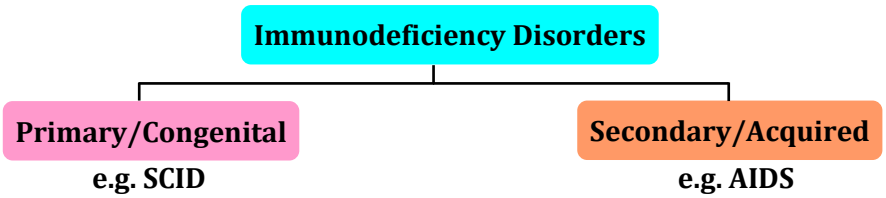
(D) Hashimoto Disease

- In this autoimmune disease, antibodies are formed against thyroid gland.
- It destroys thyroid gland and causes deficiency of thyroid hormones i.e. hypothyroidism.

(E) Multiple Sclerosis

- In this autoimmune disease, antibodies are formed against myelin sheath of nerve cells.
- It causes destruction of myelin sheath of nerve cells.
- **Symptom :** Neurological dysfunction.

(9) Immuno Deficiency Disorders :



(A) Severe Combined Immuno Deficiency (SCID) :

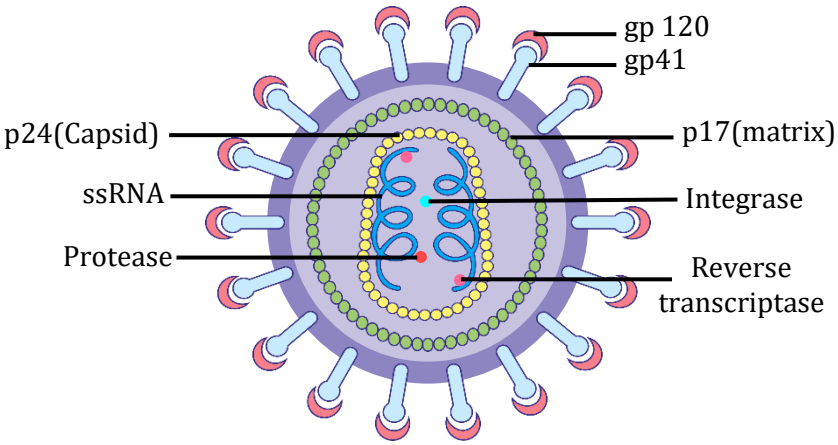
- It is due to gene mutation involving deficiency of enzyme adenosine deaminase (ADA).
- This enzyme (ADA) is involved in maturation of B- and T-lymphocytes.
- Affected individual dies at an early age.
- **Treatment :** Gene therapy

(B) Acquired Immuno Deficiency Syndrome (AIDS) :

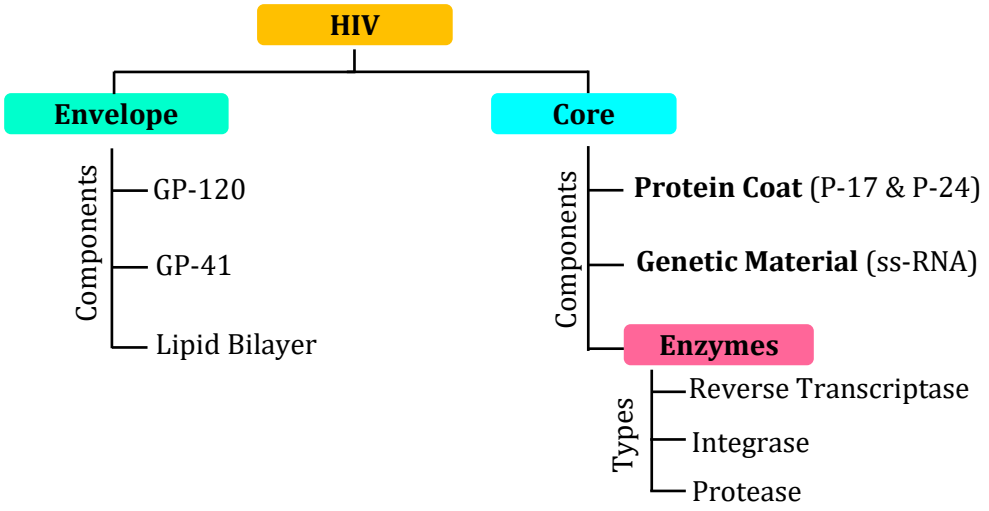
- In AIDS, its pathogen i.e. HIV attacks on T helper cells.
- It decreases count of T helper cells from 900 million per litre (normal count) to less than 200 million per litre.

AIDS :

- AIDS = Acquired Immuno Deficiency Syndrome
- Deficiency of immune system is acquired during the lifetime of an individual : **AIDS is not a congenital disease**.
- 'Syndrome' means a group of symptoms.
- AIDS was first reported in 1981 and in the last twenty-five years or so, it has spread all over the world killing more than 25 million persons.
- AIDS is caused by the Human Immuno deficiency Virus (HIV), a member of a group of viruses called retrovirus, which have an envelope enclosing the RNA genome.
- In India, first case was reported in 1986 from Chennai.



Structure of HIV



Transmission of HIV-infection generally occurs :

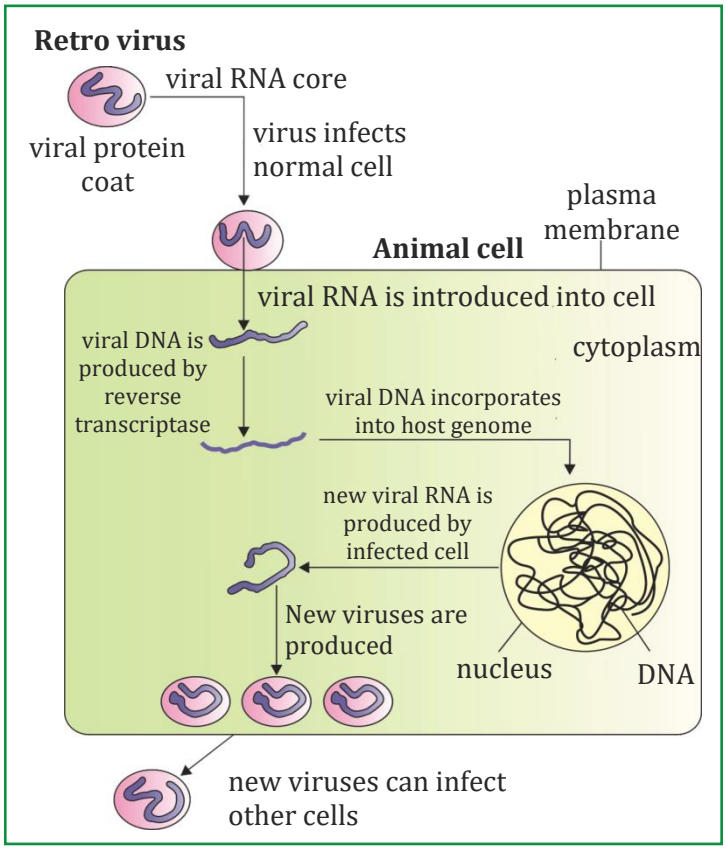
1. **Sexual route :** by sexual contact with infected person
2. **Parenteral route :**

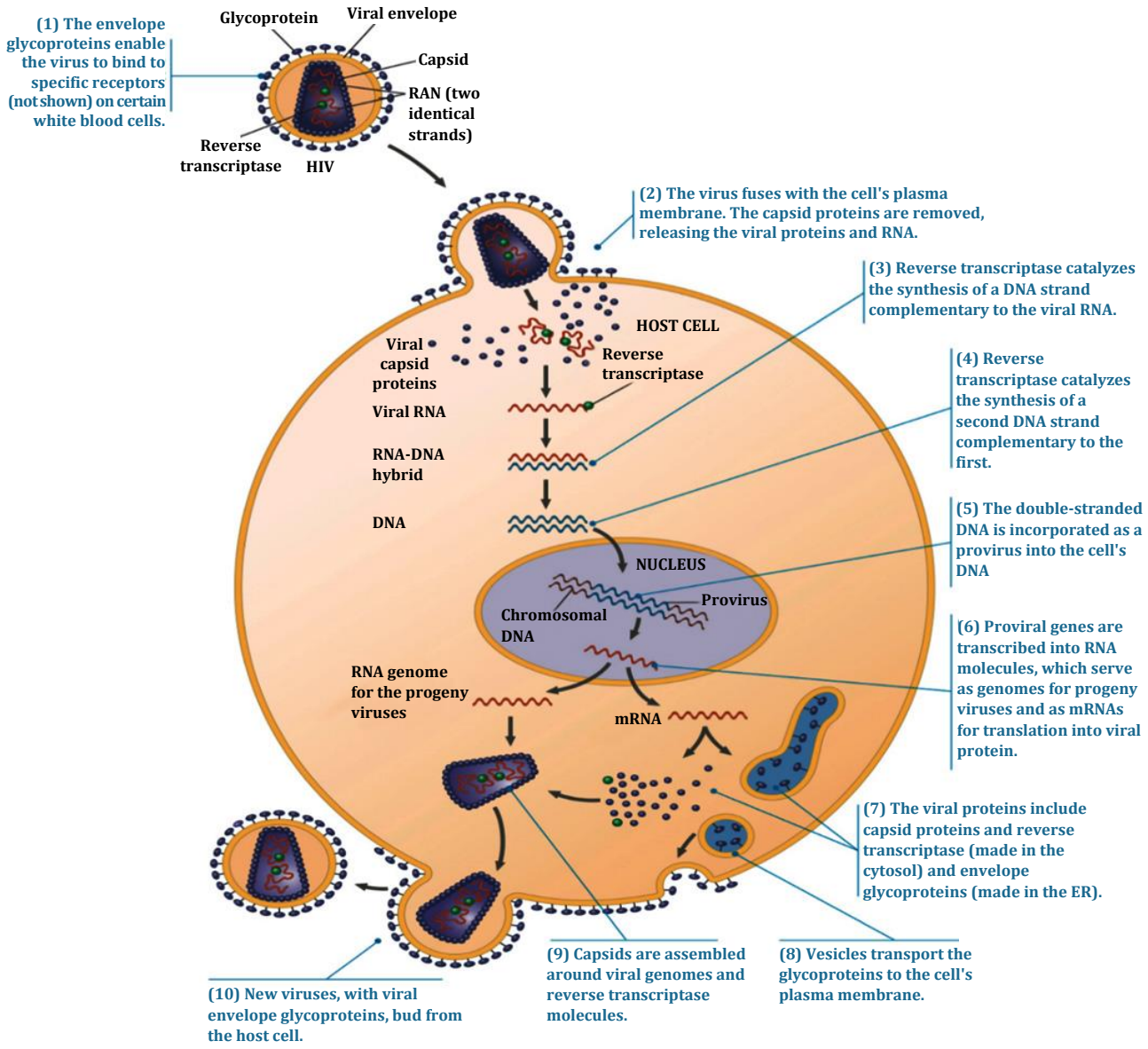
- By transfusion of contaminated blood and blood products
- By sharing infected needles as in the case of intravenous drug abusers

3. **Tranplacental route :** From infected mother to her foetus through placenta
4. From infected mother to her infant by colostrum

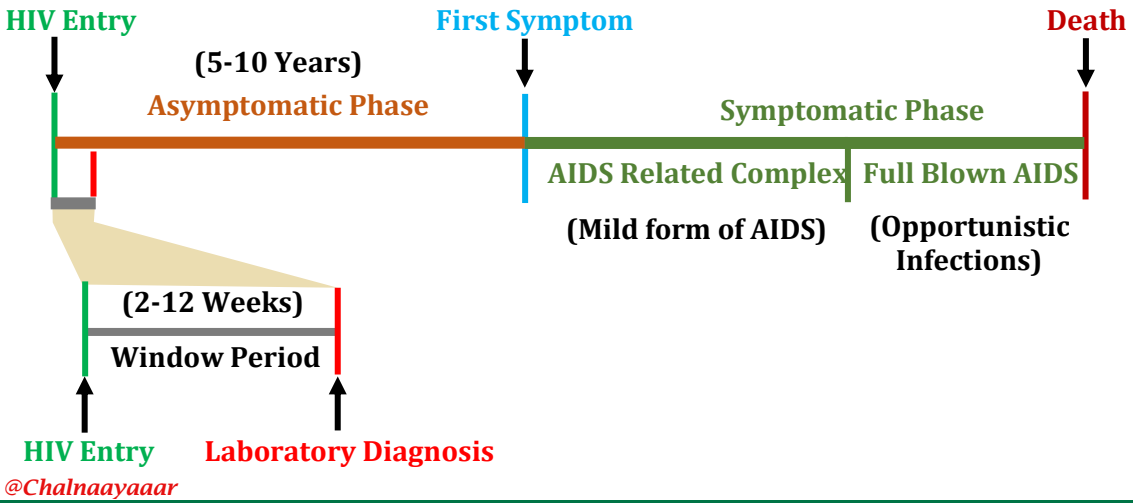
People who are at high risk of getting this infection includes :

- Individuals who have multiple sexual partners
- Individuals who required repeated blood transfusions
- Drug addicts who take drugs intravenously
- Children born to an HIV infected mother HIV/AIDS is not spread by mere touch, physical contact, hugging, kissing, sharing meals, shaking hands, mosquito bites, coughing, sneezing, looking after AIDS patients; **it spreads only through body fluids.**




(1) The envelope glycoproteins enable the virus to bind to specific receptors (not shown) on certain white blood cells.
Glycoprotein
Viral envelope
Capsid
RAN (two identical strands)
Reverse transcriptase
HIV
(2) The virus fuses with the cell's plasma membrane. The capsid proteins are removed, releasing the viral proteins and RNA.
(3) Reverse transcriptase catalyzes the synthesis of a DNA strand complementary to the viral RNA.
HOST CELL
Viral capsid proteins
Reverse transcriptase
Viral RNA
RNA-DNA hybrid
DNA
(4) Reverse transcriptase catalyzes the synthesis of a second DNA strand complementary to the first.
(5) The double-stranded DNA is incorporated as a provirus into the cell's DNA
NUCLEUS
Provirus
Chromosomal DNA
(6) Proviral genes are transcribed into RNA molecules, which serve as genomes for progeny viruses and as mRNAs for translation into viral protein.
RNA genome for the progeny viruses
mRNA
(7) The viral proteins include capsid proteins and reverse transcriptase (made in the cytosol) and envelope glycoproteins (made in the ER).
(9) Capsids are assembled around viral genomes and reverse transcriptase molecules.
(8) Vesicles transport the glycoproteins to the cell's plasma membrane.
(10) New viruses, with viral envelope glycoproteins, bud from the host cell.

AIDS :



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Note :

- **Incubation period :** Time interval between the entry of pathogen and appearance of symptoms
- **Window period :** Period between infection to the time when it can be laboratorically detected
- After getting into the body of the person, the virus enters into macrophages to produce virus particles. The macrophages continue to produce virus and in this way acts like a HIV factory.
- Simultaneously, HIV enters into helper T-lymphocytes (TH), and produce progeny viruses. The progeny viruses released in the blood attack other helper T-lymphocytes. This is repeated leading to a progressive decrease in the number of helper T-lymphocytes in the body of the infected person.
- Infected cell can survive while viruses are being replicated and released.
- Due to progressive decrease in the number of helper T-lymphocytes (**normal cell count is 900 million/litre**), the person starts suffering :
- Initially from **AIDS Related Complex (ARC)** and finally from **full blown AIDS.**

AIDS Related Complex (ARC)

- Mild form of AIDS
- **Symptoms :** Bouts of fever, repeated episodes of diarrhoea, weight loss, prolonged cough, swollen lymph nodes, night sweats (in more than 50% cases), etc.

Full blown AIDS

- Cell count of helper T-lymphocytes : **Below 200 million/litre**
- Patient becomes severely immunodeficient in this period, therefore starts suffering from **opportunistic infections** (infections that could have been otherwise overcome) such as :
- **Tuberculosis** by *Mycobacterium avium* (bacterium)
- **Candidiasis (ulcers of mouth and oesophagus)** by *Candida albicans* (fungus)
- **Pneumonia** by *Pneumocystis carinii* (fungus)
- **Kaposi sarcoma (cancer of skin and lymph nodes)** by herpes virus
- **Encephalitis** by *Toxoplasma gondii* (protozoan)

Diagnosis :

- A widely used diagnostic test for AIDS is **enzyme linked immuno-sorbent assay (ELISA)**, but it is screening test only.
- Confirmatory test for AIDS is **Western blot test**.

Treatment :

1. **Reverse Transcriptase Inhibitors**
2. **Integrase Inhibitors**
3. **Protease Inhibitors**
4. **HAART (Highly Active Anti Retroviral Therapy) or Cocktail Treatment :**

- It includes both Reverse Transcriptase Inhibitors and Protease Inhibitors.
- Treatment of AIDS with anti-retroviral drugs is only partially effective. They can only prolong the life of the patient but cannot prevent death, which is inevitable.

Prevention :

- As AIDS has no cure, prevention is the best option.
- HIV infection, more often, spreads due to conscious behaviour patterns. The only excuse may be ignorance and it has been rightly said – "don't die of ignorance".

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- In our country the National AIDS Control Organisation (NACO) and other non-governmental organisation (NGOs) are doing a lot to educate people about AIDS.
- Infection with HIV or having AIDS is something that should not be hidden – since then, the infection may spread to many more people.
- WHO has started a number of programmes to prevent the spreading of HIV infection.

Some such steps :

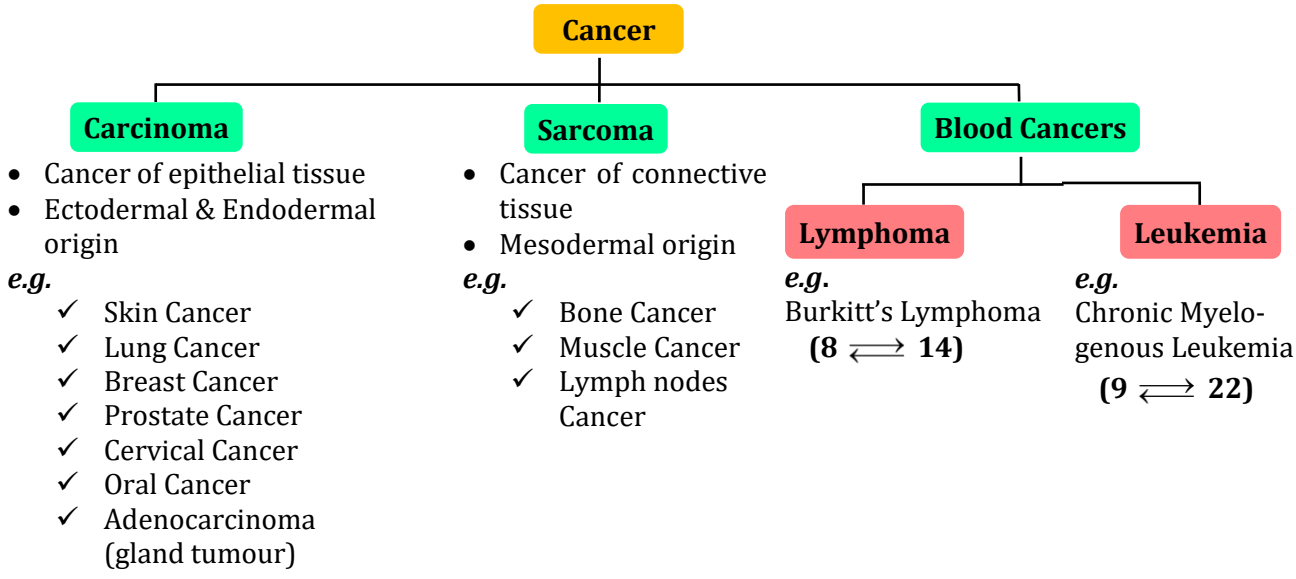
- Advocating safe sex and promoting regular check-ups for HIV in susceptible population
- Free distribution of condoms
- Making blood (from blood banks) safe from HIV
- Ensuring the use of only disposable needles and syringes in public and private hospitals and clinics
- Controlling drug abuse
- HIV/AIDS-infected people need help and sympathy instead of being shunned by society. Unless society recognises it as a problem to be dealt with in a collective manner, the chances of wider spread of the disease increase manifold.

Note : AIDS is a malady that can only be tackled, by the society and medical fraternity acting together, to prevent the spread of the disease.

10. Cancer :

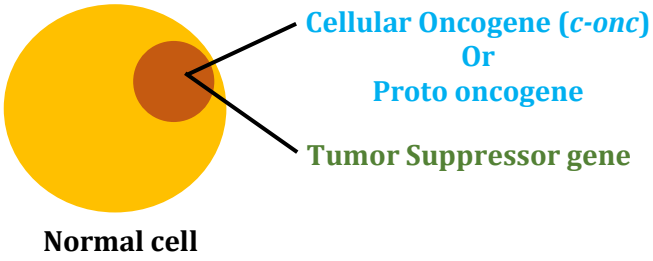
- **Cancer :** Uncontrolled, abnormal and excessive mitotic divisions of cells
- **Study of cancer :** Carcinology/Oncology
- Cancer is one of the most dreaded diseases of human beings.
- It is a major cause of death all over the globe. More than a million Indians suffer from cancer and a large number of them die from it annually.
- The mechanisms that underlie development of cancer or oncogenic transformation of cells, its treatment and control have been some of the most intense areas of research in biology and medicine.

Types of Cancer :

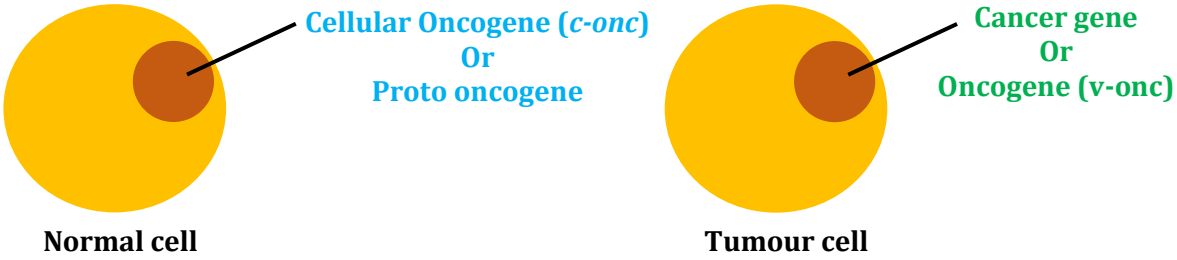


Mechanism of Cancer :

- In our body, cell growth and differentiation is highly controlled and regulated. In cancer cells, there is breakdown of these regulatory mechanisms.



- Tumour suppressor genes inhibit cellular proliferation.

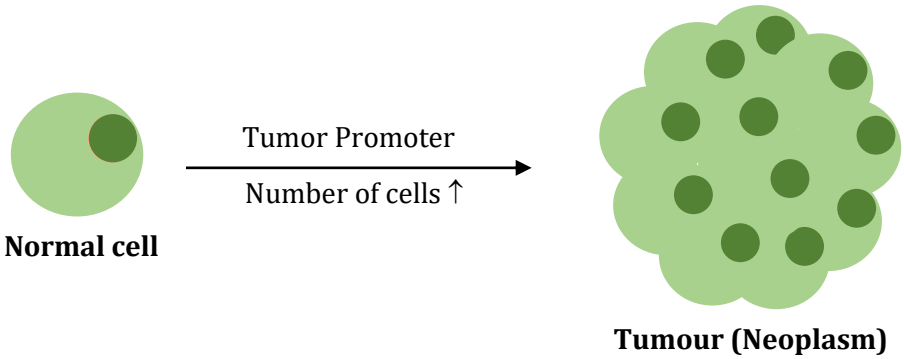


- Several genes called cellular oncogenes (*c-onc*) or proto oncogenes have been identified in normal cells which, when activated under certain conditions, could lead to oncogenic transformation of the cells.

Normal cell $\xrightarrow[\text{Induced by Carcinogens}]{\text{Oncogenic Transformation}}$ Tumour cell

Tumor Promoters :

- Agents that promote the proliferation of cells, which have already undergone genetic alternations responsible for oncogenic transformation. These agents are called tumor promoters.
  e.g. Some growth factors and hormones.



Properties of Cancer cells :

- Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibits their uncontrolled growth. Cancer cells appears to have lost this property. As a result of this, cancerous cells just continue to divide giving rise to masses of cells called tumors.
- Cancer cells are anchorage independent and insensitive to population density.
- Cancer cells are immortalised by the mechanism that maintains length of telomeres.
- Cancer cells are spread by invasion and metastasis.

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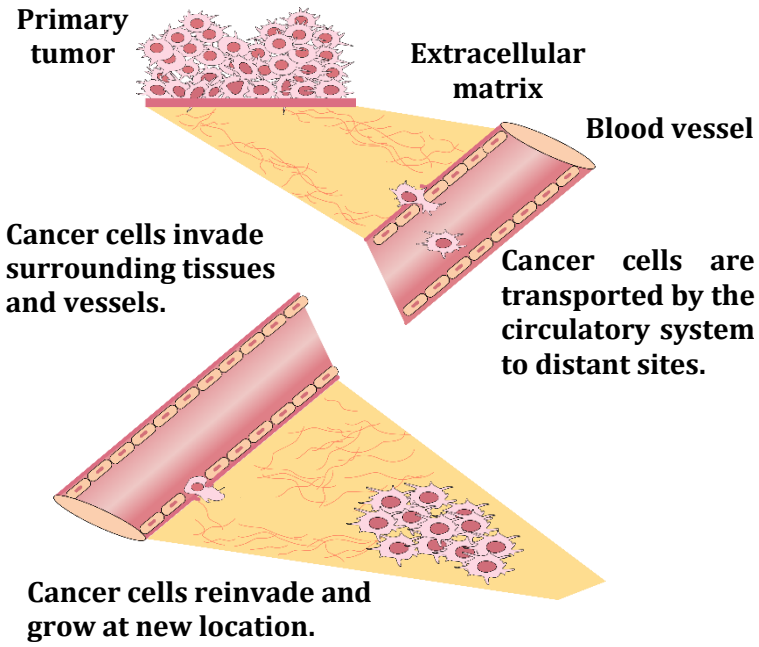
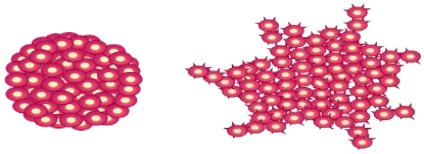
Tumors :

- Tumors are of two types: benign and malignant.
- Benign tumors normally remain confined to their original location and do not spread to other parts of the body and cause little damage.
- The malignant tumors, on the other hand are a mass of proliferating cells called neoplastic or tumor cells. These cells grow very rapidly, invading and damaging the surrounding normal tissues. As these cells actively divide and grow they also starve the normal cells by competing for vital nutrients.
- Cells sloughed from such tumors reach distant sites through blood, and wherever they get lodged in the body, they start a new tumor there. This property called **metastasis** is the most feared property of malignant tumors.


Primary tumor
Extracellular matrix
Blood vessel
Cancer cells invade surrounding tissues and vessels.
Cancer cells are transported by the circulatory system to distant sites.
Cancer cells reinvade and grow at new location.

Difference between benign tumour and malignant tumour :

Trait	Benign	Malignant
Tissue organization	Normal	Disorganized
Tumor boundary	Well defined	Poorly defined

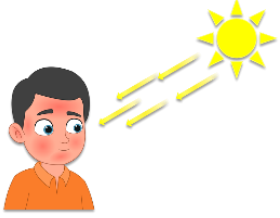


Carcinogens :

- Cancer causing agents are known as carcinogens.
- There are 3 types of carcinogens :

(1) Physical agents

- Ionising radiations like X-rays and gamma rays and non-ionizing radiations like UV rays cause DNA damage leading to neoplastic transformation.
- Sometimes, injury due to sharp teeth causes tongue cancer.
- Kashmiri people keep 'Kangri' close to skin that causes skin cancer and this skin cancer is called kangri cancer.



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(2) Chemical agents

- The chemical carcinogens present in tobacco smoke have been identified as a major cause of lung cancer.
- Tobacco chewing cause oral cancer.
- Combustion product of coal and pesticides, artificial flavour, sweeteners, synthetic food, etc cause cancer.
- Hormonal imbalance or estrogen excess causes breast cancer.
- Urinary bladder cancer is common in dye workers.

(3) Biological agents

- It includes oncogenic viruses. Oncogenic viruses have genes called viral oncogenes.
  e.g. Rous sarcoma virus, Hepatitis B & C viruses, Human papilloma virus, Epstein Barr virus, Herpes virus, etc.

Cancer Detection and Diagnosis :

- Early detection of cancers is essential as it allows the disease to be treated successfully in many cases.
- The techniques for cancer detection and diagnosis :

(1) Blood examination :

(a) Test for increased cell counts in case of leukemias
(b) Detection of the tumor markers in blood like :

- α-fetoprotein (AFP) for liver cancer
- PSA (prostate specific antigen) for prostate cancer
- alkaline phosphatase for bone metastasis

(2) Imaging (X-Ray, Sonography, CT Scan and MRI, etc.)

- These techniques are very useful to detect cancers of the internal organs.
- In X-rays scan and CT (Computed Tomography) scan, X-rays are used to generate, respectively, a two dimensional (2D) and three dimensional (3D) image of the internals of an object.
- In sonography, high frequency sound waves (ultrasound) are used to produce dynamic visual image of internal organs.
- In MRI (Magnetic Resonance Imaging), strong magnetic fields and non-ionising radiations are used to accurately detect pathological and physiological changes in the living tissue.

(3) FNAC (fine needle aspiration cytology)

- Fluid is collected from cysts/tumors and examined for presence of cancer cells.

(4) Pap smear

- It is specially used for cervical carcinoma. In it, slide is prepared from cervical fluid.

(5) Biopsy and histopathological study

- In biopsy, a piece of the suspected tissue cut into thin sections is stained and examined under microscope (histopathological studies) by a pathologist.

(6) Modern techniques

- Antibodies against cancer-specific antigens are also used for detection of certain cancers.
- Techniques of molecular biology can be applied to detect genes in individuals with inherited susceptibility to certain cancers. Identification of such genes, which predispose an individual to certain cancers, may be very helpful in prevention of cancers. Such individuals may be advised to avoid exposure to particular carcinogens to which they are susceptible.
  e.g. : Tobacco smoke in case of lung cancer

Treatment of Cancer :

- The common approaches for treatment of cancer are surgery, radiation therapy, chemotherapy and immunotherapy.

(a) Surgery :

- Entire cancerous tissue and/or involved lymph nodes are removed.

(b) Radiotherapy :

- Tumor cells are irradiated lethally, taking proper care of the normal tissues surrounding the tumor mass.

(c) Chemotherapy :

- Several chemotherapeutic drugs are used to kill cancerous cells. Some of these are specific for particular tumors.
- Anti cancerous drugs inhibit synthesis of DNA in cancer cells stopping their cell cycle.
- Majority of drugs have side effects like hair loss, anemia, etc.
- Some popular anti cancerous drugs are :

✓ Vincristine and vinblastine (Source : *Cantharanthus* roseus or Vinca rosea)

✓ Taxol (Source : *Taxus baccata)*

(d) Immunotherapy :

- **Monoclonal antibodies**
  - ✓ They are designed to attach specific proteins in cancer cells.
  - ✓ **Their uses :**
    (i) To allow the immune system itself to destroy the cancer cells.
    (ii) To deliver radiation directly to cancer cells.
    (iii) Carry drugs directly to cancer cells.
- **Cancer vaccine:** Research is in progress to develop cancer vaccines.
- Tumor cells have been shown to avoid detection and destruction by immune system. Therefore, the patients are given substances called biological response modifiers such as α-interferon which activate their immune system and help in destroying the tumor.
- The common approaches for treatment of cancer are surgery, radiation therapy, chemotherapy and immunotherapy.
- Most cancers are treated by combination of surgery, radiotherapy, chemotherapy and immunotherapy.

BEGINNER'S BOX-4 AIDS AND CANCER

1. Envelope of HIV is formed by :-
(1) P–24 (2) P–17 (3) ssRNA (4) GP–41, GP–120

2. ELISA test is used for the detection of :-
(1) HIV infection (2) Hepatitis–B (3) Both (1) and (2) (4) None of these above

3. AIDS is characterized by reduction in :
(1) Mast cells (2) Neutrophils (3) RBC (4) Helper T-cells

4. Which of the following gene is absent in a normal cell ?
(1) Proto-oncogene
(2) Tumor-suppressor gene
(3) Gene related to program cell death
(4) Oncogene

5. "Don't die of ignorance" is said for :-
(1) Cancer (2) AIDS (3) Malaria (4) Filaria

6. Which of the following statement is correct for SCID?
(1) This enzyme (ADA) is involved in maturation of B-lymphocytes only
(2) This enzyme (ADA) is involved in maturation of T-cells only
(3) Affected individual dies at an old age
(4) It is due to gene mutation involving deficiency of enzyme ADA (adenosine deaminase)

7. Nucleic acid in HIV is –
(1) ss RNA (2) ss DNA (3) ds RNA (4) ds DNA

8. Transmission of HIV occurs through.
(1) Transplacental route only (2) Sexual route only
(3) Parenteral route only (4) All of the above

9. Enzymes present in HIV is/are –
(1) Reverse transcriptase (2) Integrase
(3) Protease (4) All of the above

10. Which of the following act like HIV factory?
(1) Mast cell (2) Macrophage
(3) T-cell (4) B-cell

11. Opportunistic infections occur in HIV patient during –
(1) Window period (2) Incubation period
(3) ARC (4) Full down AIDS

12. Which of the following is not a carcinoma?
(1) Bone cancer (2) Skin cancer (3) Lung cancer (4) Cervical cancer

13. Tumour cell has –
(1) Active proto – oncogenes (2) Inactive proto – oncogene
(3) Inactive cellular oncogene (4) Tumour suppressor gene

14. Which of the following not a chemical carcinogen caused cancer?
(1) Kangri cancer (2) Lung cancer (3) Breast cancer (4) Oral cancer

15. Which of the following are oncogenic viruses?
(1) EB virus (2) Herpes virus (3) HPV (4) All of the above

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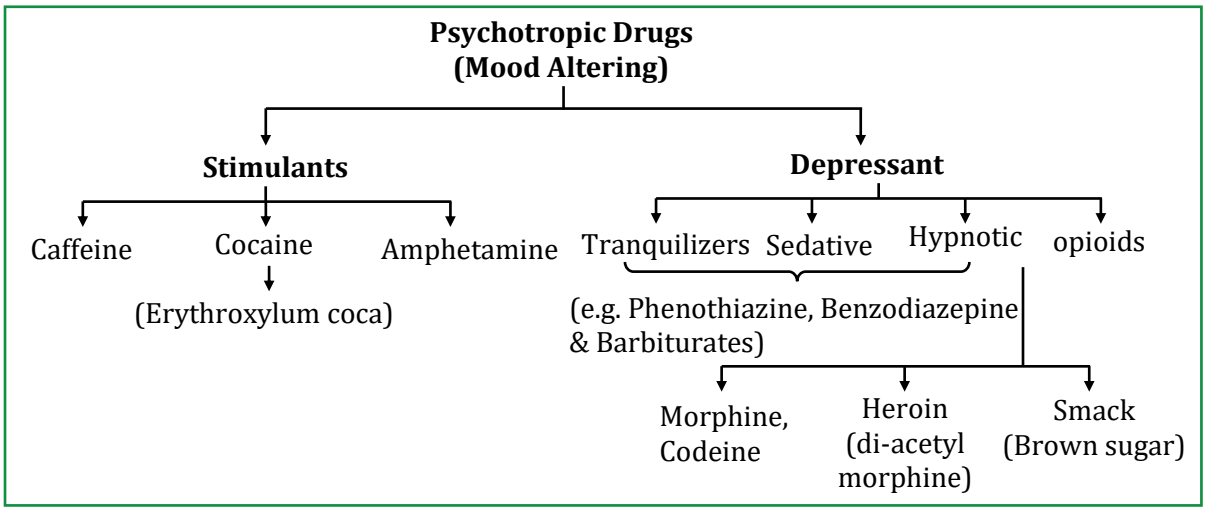
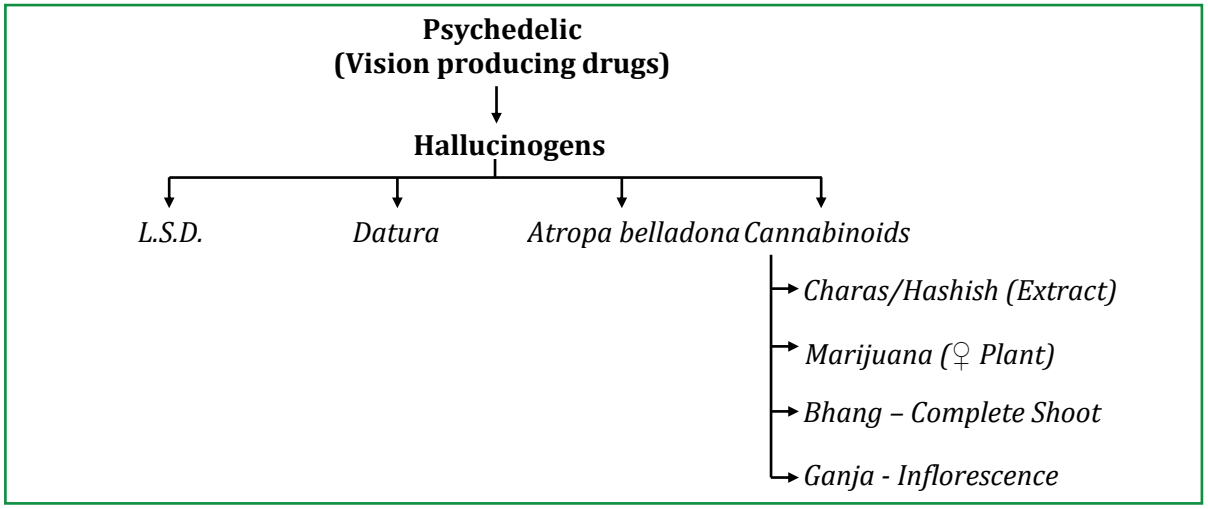
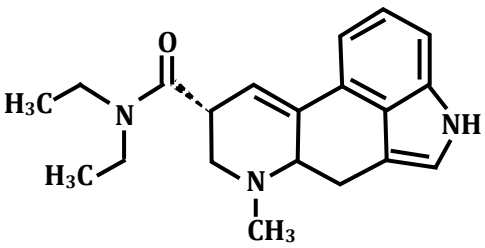
11. Drug Abuse :





When certain compounds are taken :

- For a purpose other than medicinal use or
- In amounts/frequency that impairs one's physical, physiological or psychological functions.
- Majority of these are obtained from flowering plants, but some drugs are obtained from fungi. For e.g. LSD (Lysergic acid Diethylamide) (Fruiting body of fungus claviceps purpurea)



The drugs, which are commonly abused are :

(1) Opioids

Examples:

- Natural: Morphine
- Synthetic: Heroine (Diacetyl morphine) [White, odourless, bitter crystalline compound]

Source

- Morphine : Extracted from the latex of poppy plant *Papaver somniferum*
- Heroine : Obtained by acetylation of morphine

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Mode of intake
Generally by– Snorting, Injection

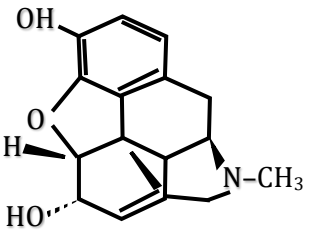
Mechanism of action

- Binding with specific opioid receptors present in central nervous system and gastrointestinal tract

Effects on body

- Morphine : Very effective sedative and painkiller, and is very useful in patients who have undergone surgery
- Heroine : A depressant and slows down body functions

Papaver somniferum (Poppy plant)



Morphine

(2) Cannabinoids

Examples:

- Bhang
- Marijuana, Hashish, Charas and Ganja

Source

- Natural : Inflorescences of the cannabis plant *Cannabis sativa*
- Marijuana, Hashish, Charas and Ganja : Flower tops, leaves and the resin of cannabis plant are used in various combinations for production

Mode of intake

- Generally by inhalation and oral ingestion

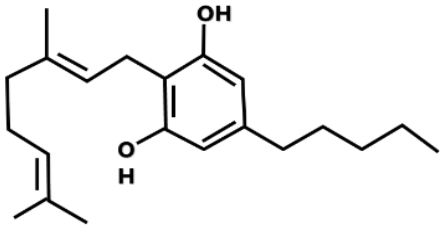
Mechanism of action

Interacting with cannabinoid receptors present principally in the brain

Effects on body

- Effects on cardiovascular system of the body
- Also being abused by some sports persons these days

Leaves of *Cannabis sativa*



Skeletal structure of cannabinoid molecule

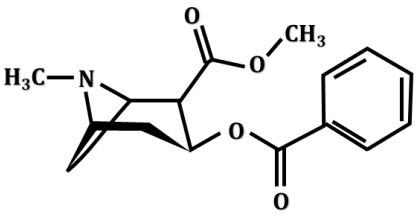
(3) Coca alkaloids

Examples

- Cocaine, commonly called coke or crack

Source

- Coca plant *Erythroxylum coca*, native to South America.



Mode of intake – Usually by snorting

Mechanism of action

- Interference with the transport of the neuro-transmitter dopamine

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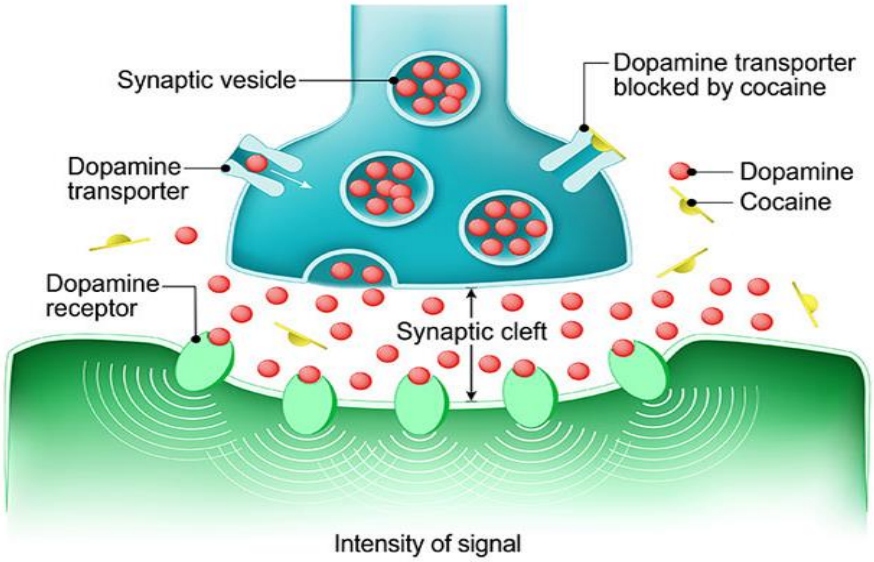

Interference of cocaine with transport of neuro-transmitter dopamine

Effects on body

- Potent stimulating action on central nervous system, producing a sense of euphoria and increased energy.
- Excessive dosage causes hallucinations
- Several plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe.
- Well-known plants with hallucinogenic properties are *Atropa belladona* and *Datura.*
- Drugs like barbiturates, amphetamines, benzodiazepines, and other similar drugs, that are normally used as medicines to help patients cope with mental illnesses like depression and insomnia, are often abused.

Flowering branch of *Datura*

12. Addiction and Dependence :

- The most important thing, which one fails to realise, is the **inherent addictive nature** of tobacco, alcohol and drugs.
- **Addiction :** Psychological attachment to certain effects- such as euphoria and a temporary feeling of well being- associated with drugs×.
- **Dependence :** The tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drugs× is abruptly discontinued.

- **Withdrawal Syndrome :**
  - ✓ Characterised by anxiety, shakiness, nausea and sweating, etc. which may be relieved when use of drugs× is resumed again
  - ✓ In some cases, withdrawal symptoms can be severe and even life threatening and the person may need medical supervision.

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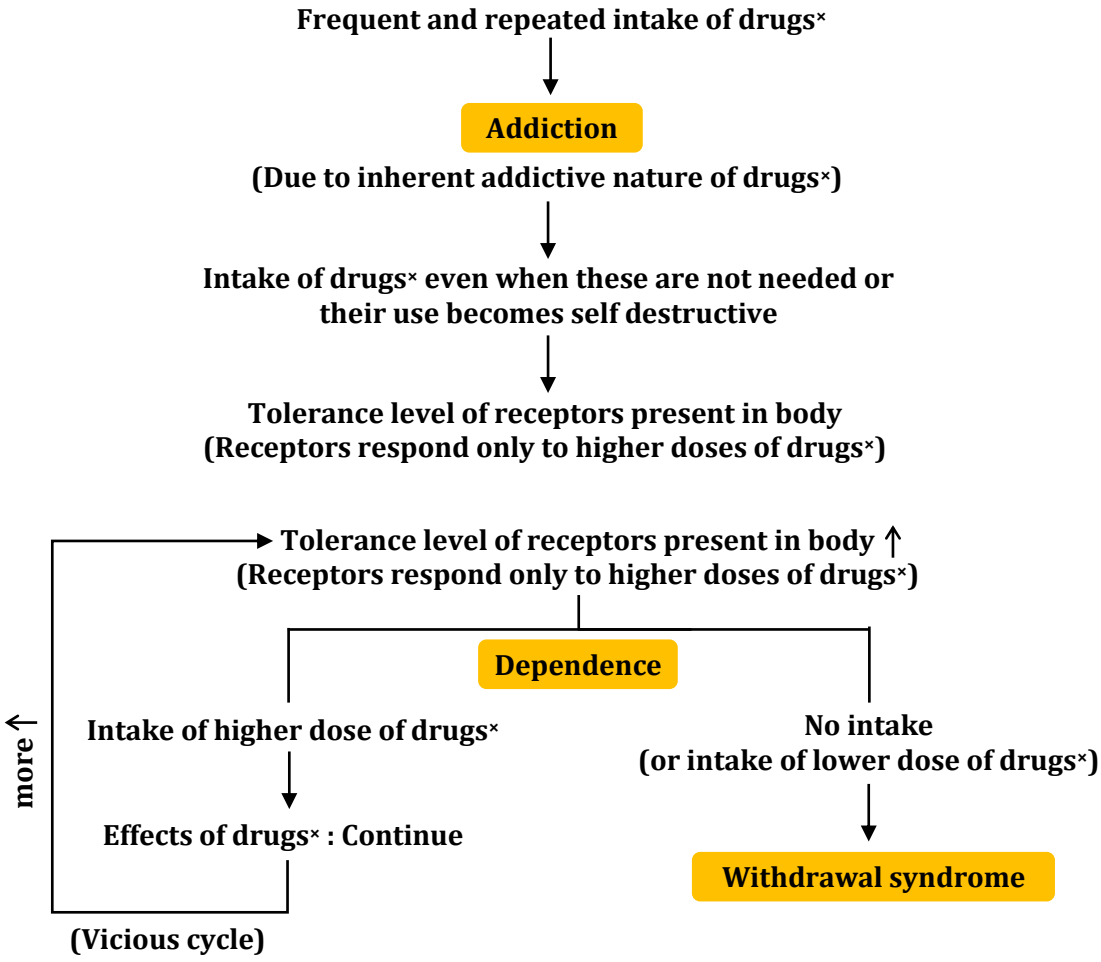
Frequent and repeated intake of drugs×
Addiction
(Due to inherent addictive nature of drugs×)
Intake of drugs× even when these are not needed or their use becomes self destructive
Tolerance level of receptors present in body
(Receptors respond only to higher doses of drugs×)
Tolerance level of receptors present in body ↑
(Receptors respond only to higher doses of drugs×)
Dependence
Intake of higher dose of drugs×
more
Effects of drugs× : Continue
(Vicious cycle)
No intake
(or intake of lower dose of drugs×)
Withdrawal syndrome

Effects of Drug / Alcohol Abuse :

Immediate adverse effects of drugs and alcohol abuse :

- Reckless behaviour
- Vandalism
- Violence

Excessive doses of drugs may lead to :

- Coma
- Death due to respiratory failure, heart failure or cerebral haemorrhage

Note : A combination of drugs or their intake along with alcohol generally results in overdosing and even deaths.

Most common warning signs of drug and alcohol abuse among youth include :

- Drop in academic performance
- Unexplained absence from school/college
- Lack of interest in personal hygiene
- Withdrawal
- Isolation
- Depression
- Fatigue

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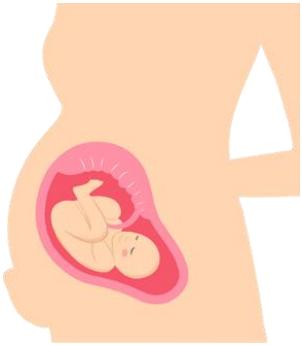
- Aggressive and rebellious behaviour
- Deteriorating relationships with family and friends
- Loss of interest in hobbies
- Change in sleeping and eating habits
- Fluctuation in weight, appetite, etc.

Dependence leads to possible far-reaching implications of drug/alcohol abuse :



- Ignorance of all social norms by abuser in order to get sufficient funds to satiate his/her needs, resulting in many social adjustment problems
- Mental and financial distress to entire family and friends of abuser etc
- The chronic use of drugs and alcohol damages nervous system and liver (cirrhosis).
- Those who take drugs intravenously (direct injection into the vein using a needle and syringe), are much more likely to acquire serious infections like AIDS and Hepatitis B. Both AIDS and Hepatitis B infections are chronic infections and ultimately fatal.
- The use of drugs and alcohol during pregnancy is also known to adversely affect the foetus.

Certain sportspersons (mis)use :

- Narcotic analgesics
- Anabolic **steroids**
- Diuretics and certain hormones
- In sports to increase muscle strength and bulk and to promote aggressiveness and as a result increase athletic performance.

The side-effects of the use of anabolic steroids in males include :

- Acne
- Increased aggressiveness
- Mood swings
- Depression
- Reduction of size of the testicles
- Decreased sperm production
- Potential for kidney and liver dysfunction
- Breast enlargement
- Premature baldness
- Enlargement of the prostate gland

The side-effects of the use of anabolic steroids in females include :

- Masculinisation (features like males)
- Increased aggressiveness
- Mood swings

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- Depression
- Abnormal menstrual cycles
- Excessive hair growth on the face and body
- Enlargement of clitoris
- Deepening of voice

Note : These side effects in males or females may be permanent with prolonged use.

- In the **adolescent male or female**, severe facial and body acne, and premature closure of the growth centres of the long bones may result in stunted growth.

Prevention and Control of Drug/Alcohol Abuse :

- The age-old adage of **'prevention is better than cure'** holds true here also.
- Measures particularly useful for prevention and control of alcohol and drugs abuse among adolescents :

✓ Avoid undue peer pressure
✓ Education and counselling
✓ Seeking help from parents and peers
✓ Looking for danger signs
✓ Seeking professional and medical help

13. Alcohol Abuse :

- Ethyl alcohol is consumed as fermented beverages with low content of alcohol (like beer, wine, etc.) and as distilled beverages with a relatively high alcohol percentage (like brandy, rum, whisky, gin, etc.).
- This alcohol is rapidly absorbed from the wall of stomach and enters the blood stream within minutes of ingestion.
- In liver, alcohol is converted into a more toxic substance acetaldehyde.

Effects of alcohol abuse :

1. On liver :

- Alcoholic fatty liver
- Alcoholic cirrhosis

2. On brain :

- Depression
- The cerebrum part is affected first (The abuser loses judgement, self control and will power).
- And then cerebellum part is affected (control and coordination of the muscles of the abuser is affected)
- Amnesia lass of memory

3. Lowering of blood sugar level **(Hypoglycaemia)**
4. Body resistance against diseases is reduced.
5. Impotency and Infertility
6. Foetal Alcohol Syndrome (FAS) (Due to heavy drinking by mother during pregnancy)
7. Oesophagitis and gastritis

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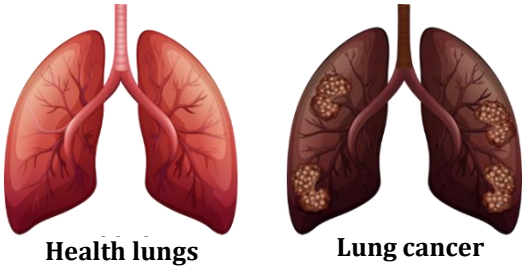
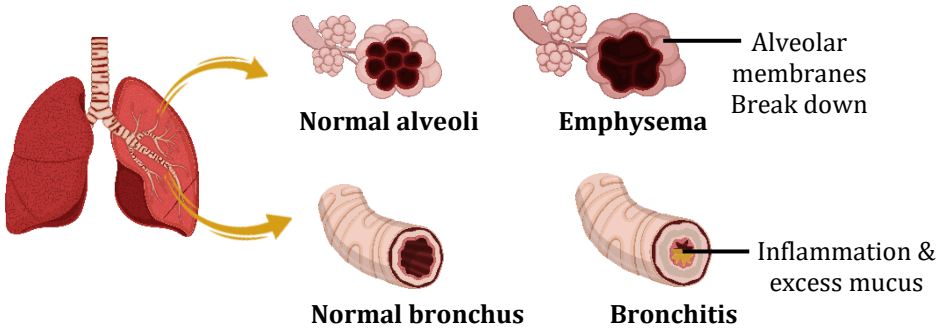
14. Tobacco Abuse :

- Tobacco has been used by human beings for more than 400 years.
- Tobacco is smoked, chewed or used as a snuff.
- Tobacco contains a large number of chemical substances including nicotine, an alkaloid.
- Nicotine stimulates adrenal gland to release adrenaline and nor-adrenaline into blood circulation, both of which raise blood pressure and increase heart rate.
- Smoking increases carbon monoxide (CO) content in blood and reduces the concentration of haem bound oxygen. This causes oxygen deficiency in the body.



- Smoking also paves the way to hard drugs.
- Smoking is associated with increased incidence of :-

(i) Cancers of lung, urinary bladder and throat
(ii) Emphysema
(iii) Bronchitis



(iv) Coronary heart disease (Lumen of blood vessels become narrow)
(v) Intestinal ulcer.

- Tobacco chewing is associated with increased risk of cancer of the oral cavity.
- When one buys packets of cigarettes one cannot miss the statutory warning that is present on the packing which warns against smoking and says how it is injurious to health.

15. Adolescence and Drug/Alcohol Abuse :

Adolescence :

- Both 'a period' and 'a process'
- Period between 12-18 years of age
- During it, a child becomes mature in terms of his/her attitudes and beliefs for effective participation in society.
- In other words, a bridge linking childhood and adulthood
- Accompanied by several biological and behavioural changes
- Thus, is a very vulnerable phase of mental and psychological development of an individual.

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Causes for motivation among adolescents/ youngsters towards tobacco, alcohol and drugs use :

Initially :

- Natural curiosity
- Need for adventure and excitement
- Experimentation
- Perception that it is 'cool' or progressive to smoke, use drugs or alcohol (television, movies, newspapers, internet also help to promote this perception)

_____ (effects perceived as benefits) _____

Later :

- To escape facing problems
- Due to stress from pressures to excel in academics or examinations and also
- Due to unstable or unsupportive family structures and peer pressure, etc.

BEGINNER'S BOX-5 DRUGS AND ALCOHOL ABUSE

1. Which of the following is included in cannabinoid ?
(1) Morphine (2) Heroin (3) Codeine (4) Charas

2. Receptors of opioids are present in :-
(1) CNS (2) GIT (3) Both (1) and (2) (4) Spleen

3. Which of the following is used as opioid analgesics ?
(1) Paracetamol, Aspirin (2) Morphine, Codeine
(3) Nimesulide, Penicillin (4) Ciprofloxacin, Ampicillin

4. Tabacco chewing is associated with increased risk of which cancer ?
(1) Oral cancer (2) Lung cancer
(3) Urinary bladder cancer (4) Prostate cancer

5. Drug extracted from latex of poppy plant *Papaver somniferum* is –
(1) Morphine (2) Heroine (3) Smack (4) All of the above

6. Organ system affected by opioids are –
(1) CNS (2) BVS (3) GIT (4) Both (1) and (3)

7. In liver, alcohol gets converted into more toxic substance –
(1) Acetaldehyde (2) Acetone
(3) Formaldehyde (4) Ketone

8. Adolescents get indulged in tobacco, alcohol and drugs due to –
(1) Peer pressure (2) Natural curosity
(3) Perception of cool and progressive (4) All of the above

9. Immediate adverse effect of drugs and alcohol abuse are –
(1) Reckless behaviour (2) Vandalism
(3) Violence (4) All of the above

10. Intra-venous drugs may lead to chronic and fatal injection like –
(1) AIDS (2) Hepatitis-B
(3) Both (1) and (2) (4) None of the above

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BEGINNER'S BOX — ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	4	4	4	4	3	2	3	4	4
	Que.	11	12	13	14	15					
	Ans.	2	2	2	2	3					

BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	1	4	4	4	4	2	1	4	3
	Que.	11	12	13	14	15	16	17	18	19	20
	Ans.	4	4	2	2	3	1	3	3	2	1

BEGINNER'S BOX-3	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	3	4	4	2	4	1	4	3	1	4

BEGINNER'S BOX-4	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	3	4	4	2	4	1	4	4	2
	Que.	11	12	13	14	15					
	Ans.	4	1	1	1	4					

BEGINNER'S BOX-5	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	3	2	1	4	4	1	4	4	3

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ESSENCE

Immunity
(Ability of host to fight the disease-causing organism)

Innate immunity
- Congenital
- Non-specific
- Consists of 4 types of barriers
  (i) **Physical** = Skin, Mucosa
  (ii) **Physiological** = Saliva, Tear, Gastric Juice
  (iii) **Cellular** = PMNL-neutrophils, Monocytes, NK cells, Macrophage
  (iv) **Cytokine** = Interferons

Acquired immunity
- After birth
- Specific
- Characterised by **Memory**

Active Immunity
- Natural active immunity by infection
- Artificial active immunity by vaccine

Passive Immunity
- Natural passive immunity ***e.g.*** – IgG (placenta) IgA (Colostrum)
- Artificial passive immunity ***e.g.*** Preformed antibodies

Lymphoid organs
(Where origin, maturation and proliferation of lymphocytes occur)

Primary Lymphoid Organs
(Bone-marrow, Thymus)

Immature lymphocytes → Antigen sensitive lymphocytes

Bone marrow : Main lymphoid organ

Secondary Lymphoid Organs

Spleen
Lymph-nodes
Tonsils
Payer's patches
Appendix
MALT [50%]
(Mucosa Associated Lymphoid Tissues)

Provide site for interaction of lymphocytes with the antigen

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Cancer

- One of the most dreaded disease of human beings.
- Develops due to Oncogenic transformation.

Oncogenic transformation

Proto-Oncogenes (Normal cells) → Follow **'Contact inhibition'** phenomenon

Oncogenes (Cancer cells) → Do not follow **contact inhibition** so, divide to form **Tumor**

Tumor

Benign (Non cancerous)
Remains confined to origin site

Malignant (Cancerous)
Show metastasis (most feared property)

Neoplastic or tumor cells

Invades surrounding tissues

Drugs

Opioids

Opioid receptors are present in CNS and GIT
e.g. **Heroin** and **Morphine**

- Diacetylmorphine
- White
- Odourless
- Bitter
- Crystalline
- Depressant

- Extracted from
- Latex of poppy plant
- It is effective sedativeand painkiller, used for post surgical pain

Other abused drugs

- Barbiturates
- Amphetamines
- Benzodiazepines
- LSD [most potent hallucinogen]

Cannabinoids

Receptors present in Brain, natural cannabinoids are obtained from inflorescence of **Cannabis sativa**
e.g. Marijuana, Hashish, Charas, Ganja

Coca alkaloid

Obtained from **Erythroxylum coca** (native to S. America),
e.g. Cocaine/Coke/Crack, it produces a sense of **euphoria,**
high dose causes **hallucination**
like **Datura, Atropa belladona**

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